CTIA – THE WIRELESS ASSOCIATION® RESPONSE TO HOUSE ENERGY AND COMMERCE WHITE PAPER ON MODERNIZING U.S. SPECTRUM POLICY

CTIA – The Wireless Association® ("CTIA") submits the following response to the White Paper released by the House Committee on Energy and Commerce ("Committee") on April 1, 2014, seeking comment on modernizing U.S. spectrum policy, as a part of the Committee's ongoing efforts to reform the Communications Act of 1934, as amended (the "Act").[1/]

I. INTRODUCTION AND SUMMARY

CTIA applauds the Committee's continued interest in spectrum policy and appreciates the opportunity to provide the Committee with this response. As CTIA has noted in testimony before Congress, America is the world's wireless industry leader, and the wireless marketplace is a significant driver of the U.S. economy.[2/] In 2013 alone, U.S. wireless carriers invested approximately $34 billion in their networks, which amounts to $104 per subscriber.[3/] This was not an anomaly. Indeed, since 2001, U.S. wireless carriers have invested nearly $300 billion in their networks,[4/] a figure which does not include the more than $35 billion in carrier expenditures

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1/ *See* House Committee on Energy and Commerce, *Modernizing the U.S. Spectrum Policy* (April 1, 2014) ("White Paper"), *available at* http://energycommerce.house.gov/sites/republicans.energycommerce.house.gov/files/analysis/CommActUpdate/20140401WhitePaper-Spectrum.pdf; 47 U.S.C. § 151 *et seq.*

2/ *See, e.g.*, Testimony of Christopher Guttman-McCabe, Vice President of Regulatory Affairs, CTIA – The Wireless Association®, on Military Space Programs and Views of DoD Usage of the Electromagnetic Spectrum, Before the Senate Committee on Armed Services, Subcommittee on Strategic Forces at 1-2 (April 24, 2013), *available at* http://www.armed-services.senate.gov/imo/media/doc/Guttman-McCabe_04-24-13.pdf.

3/ *See* CTIA, *US Invests Four Times More in Networks* (March 13, 2014), *available at* http://www.ctia.org/resource-library/facts-and-infographics/archive/us-investment-networks ("CTIA March 2013 Wireless Facts") (citing Didier Scemama, *et al.*, *2014 Wireless Capex: BRICs & Europe to Pick Up the Slack*, Bank of America Merrill Lynch, Global Telecom Equipment, at Table 2 (Jan. 13, 2014); Glen Campbell, *2014: The Year Ahead*, Bank of America Merrill Lynch, Global Wireless Matrix 4Q13, at Tables 1 and 2 (Jan. 8, 2014) ("Global Wireless Matrix")).

4/ *See id.*; *see also* CTIA, *The U.S. Wireless Industry: Leading the World in Investment, Value, Innovation, and Competition*, at 3 (Nov. 2013), *attached to* Letter from Scott K. Bergmann, Vice

on spectrum auctioned by the Federal Communications Commission ("FCC" or "Commission").[5/]

This massive capital investment not only reflects the existence of a vibrant and competitive wireless marketplace, but it also serves as a catalyst for what CTIA calls the "virtuous cycle" of wireless investment and innovation. Sustained capital expenditures facilitate the creation of networks capable of supporting greater speeds and functionalities, which, in turn, result in the introduction of new, more powerful and sophisticated devices. These new devices encourage the development of new applications and content used by consumers and businesses to promote productivity, access information, and increase security. Each point along this cycle leads to job creation and economic development.

American consumers and businesses have become the world's wireless winners as a result of this "virtuous cycle," benefitting from better value and more cutting-edge wireless products and services than in other countries.[6/] In the U.S. market, the most advanced Long-Term Evolution ("LTE") deployments have produced nearly half of the world's 4G subscribers,

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President, Regulatory Affairs, CTIA, to Hon. Thomas E. Wheeler *et al.*, FCC, GN Docket No. 09-51, WT Docket No. 13-135 (filed Nov. 13, 2013) ("2013 CTIA Wireless Industry Report").

5/ This figure represents auction revenue since 2001. Dating to the adoption of the auction mechanism as part of the Omnibus Budget Reconciliation Act of 1993, spectrum auctions have resulted in total revenues of $53.56 billion, per the FCC Fiscal Year 2015 Budget Estimate as supplemented by auction revenue data for 2013 to 2014 from the FCC's Wireless Telecommunications Bureau Auction Home page. *See* FCC, *Fiscal Year 2015 Budget Estimates Submitted to Congress*, at 36 (March 2014), *available at* http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db0307/DOC-325947A1.pdf; Auctions Home, Wireless Telecommunications Bureau, FCC, http://wireless.fcc.gov/auctions/default.htm?job=auctions_home (last visited April 24, 2014).

6/ CTIA, *Policy Topics: Innovation*, http://www.ctia.org/resource-library?Types=Policy%20Topics&Topics=53ac909c41746fcd88eaff000002c0f4&OrderBy=SortTitle (last visited April 24, 2014); CTIA, *CTIA Statement on the White House's Executive Memorandum on Expanding America's Leadership in Wireless Innovation* (June 14, 2013), *available at* http://www.ctia.org/resource-library/press-releases/archive/ctia-statement-white-house-expanding-leadership-in-wireless-innovation.

despite the fact that the U.S. has just five percent of the world's overall wireless subscribers.[7/] These subscribers use innovative devices that run on chips and operating systems developed by American companies like Qualcomm, Apple, Google, and Microsoft. And these U.S.-derived networks, devices, and operating systems serve as the foundation for a fertile applications development industry – also with its hub in America – that is helping transform the way we consume information and engage in commerce.[8/]

This "virtuous cycle" of innovation and investment also benefits consumers by driving the mobile ecosystem into new areas, including health care, education, farming, intelligent transportation, fleet management, mobile commerce, safety and security, small business efficiency, and more. As Cisco reports, the growth in 4G technologies – which is characterized by higher bandwidth, lower latency, and increased security – will lead to even higher adoption of mobile technologies by end users, permitting even greater access to any content on any device

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7/ *See* 2013 CTIA Wireless Industry Report at 5. As of April 2014, the U.S. was estimated to have approximately 48 percent of the world's LTE subscribers, according to the Informa Telecoms & Media Group's World Cellular Information System ("WCIS") database.

8/ *See, e.g.*, 2013 CTIA Wireless Industry Report at 6 ("The wireless industry in the U.S. directly or indirectly employs more than 3.8 million Americans, which accounts for 2.6% of all U.S. employment."); Prepared Remarks of FCC Chairman Tom Wheeler, Wireless Spectrum and the Future of Technology Innovation Forum, The Brookings Institute, Washington, D.C., at 5 (March 24, 2014), *available at* http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db0324/DOC-326215A1.pdf ("Think about the iPhone and Android phones, which have given more than 60% of Americans more computing power in their pocket than the module that put a man on the moon. . . . In barely six years, those platforms have given rise to the apps economy, which has already created more than 750,000 new U.S. jobs and put a solution to countless problems just one finger-tap away. Think about what U.S. innovators and entrepreneurs will come up with for these platform over the next six years? The next 16? Or the next 60?").

from anywhere.[9/] This is all occurring in an environment where the Bureau of Labor Statistics Wireless Price Index has declined more than 10 percent over the last five years.[10/]

Recognizing the value and resilience of LTE technology, an increasing number of consumers have chosen to go "wireless-only," severing their retail relationship with the wireline industry.[11/] Similarly, a growing number of consumers use their wireless device as their on-ramp to the Internet, and it was recently estimated that 50 million people in the U.S. now watch video on their mobile phones.[12/] Irrespective of service (voice, data, and video), consumers now spend more minutes per day focused on their smartphones (151 minutes) than on televisions (147 minutes), and the disparity is even greater when tablet use (43 minutes) is aggregated with smartphone use.[13/]

Maintaining the United States' position of leadership in the wireless industry and addressing consumers' evolving demands requires an on-going commitment to policies that ensure wireless providers have access to a significant and predictable supply of spectrum. Spectrum is the most significant resource for wireless networks. Thus, as spectrum usage and

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9/ Cisco, *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2013–2018*, at 10 (Feb. 5, 2014) ("Cisco Report"), *available at* http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.pdf.

10/ *See generally* Consumer Price Index – March 2014, Bureau of Labor Statistics, U.S. Department of Labor News Release (April 15, 2014), *available at* http://www.bls.gov/news.release/pdf/cpi.pdf.

11/ *See Wireless Substitution: Early Release of Estimates from the National Health Interview Survey, January-June 2013*, Centers for Disease Control, at 1 (Dec. 2013), *available at* http://www.cdc.gov/nchs/data/nhis/earlyrelease/wireless201312.pdf (finding that, as of June 2013, two in every five American homes (39.4 percent) had only wireless telephones, an increase of 1.2 percentage points since the second half of 2012).

12/ *See* Tony Danova, *The Great Audience Shift: People Are Watching Tons Of Video On Mobile, And Media Companies Are Trying To Cash In*, BUSINESS INSIDER (Feb. 10, 2014), http://www.businessinsider.com/mobile-video-market-growth-2014-2#ixzz2zWULb7GG.

13/ *See* Millward Brown, AdReaction 2014, http://millwardbrown.com/adreaction/2014/#/main-content (last visited April 24, 2014).

demand grow – and they are projected to do so at impressive rates, as both Cisco and Ericsson have documented[14/] – so too does the need for ever-more robust networks and more spectrum. America is only now at a level comparable to other countries with respect to spectrum usable for commercial broadband. Nonetheless, as demonstrated by the chart below, the U.S. efficiently supports more customers and more usage of spectrum than other countries, with U.S. consumers receiving more service for their telecommunications dollar.[15/]

	USA	Canada	France	Germany	Italy	Japan	Spain	U.K.
Subscribers	335M	28M	78M	114M	92M	140M	52M	78M
Average Consumer MOU/Mo.	933	394	243	135	202	115	160	188
Subscribers per MHz of Spectrum Allocated	698,644	82,840	124,324	185,366	170,370	280,000	86,667	130,478
Number of Major Incumbents	4	3	4	4	4	3	4	4
MHz Assigned for Licensed Commercial Use	479.5	338	555	615	540	500	600	597.8
Potentially Usable MHz in the Pipeline	65 + BIA	113	50	0	20	255	0	0

Despite U.S. carriers' efficient use of spectrum, more is required to continue to foster economic growth. Accordingly, additional infusions of cleared, licensed spectrum for commercial mobile use should be the top priority of our nation's spectrum policy. In addition, CTIA recommends that Congress:

- Promote more comprehensive spectrum management by considering changes to the National Telecommunications and Information Administration ("NTIA")'s role to permit, consistent with national security concerns, most spectrum use decisions to be made by the FCC;
- Adopt spectrum policy that emphasizes licensed spectrum in bands suited for mobile broadband, directs spectrum sharing where and when clearing is not

14/ *See* Cisco Report; Ericsson, *Ericsson Mobility Report on the Pulse of the Networked Society, Interim Report* (Feb. 2014), *available at* http://www.ericsson.com/res/docs/2014/ericsson-mobility-report-february-2014-interim.pdf.

15/ *See* Global Wireless Matrix at Tables 1-2; Craig Moffett, *et al., AT&T, Vodafone, & Global Wireless: Will the U.S. Look Like Europe, or Will Europe Look Like the U.S.?*, MoffettNathanson Research, at 7 (Jan. 13, 2014); *see also* Comments of CTIA – The Wireless Association®, WT Docket No. 13-135, at 67-68 (filed June 17, 2013); 2013 CTIA Wireless Industry Report at 12.

feasible, with a preference for transitional sharing over long-term sharing, and provides opportunities for unlicensed use in bands that may not be suited or available for licensed use;

- Direct the Commission and others to expedite access to wireless facilities consistent with Congressional directives; and
- Provide the FCC with appropriate spectrum management tools, including permitting the agency to centralize spectrum management in a single bureau, adopt flexible license use policies, implement flexible build-out obligations, and utilize receiver standards when necessary.

By acting consistent with these recommendations, the Committee will ensure that wireless providers have access to the spectrum necessary to facilitate an innovative and competitive mobile services marketplace to the benefit of American consumers.

II. CONGRESS SHOULD PROMOTE MORE COMPREHENSIVE SPECTRUM MANAGEMENT

The White Paper observes that NTIA oversees the domestic use of federal spectrum, assigning it to agencies and managing its use in coordination with the FCC.[16/] The FCC, in turn, manages non-federal use of spectrum. The distinctions between "federal" and "non-federal" spectrum however, are, as the White Paper points out, administrative creations made through agreements between NTIA and the FCC.[17/] The White Paper therefore asks about the role that NTIA should play in the licensing and management of spectrum. As discussed in further detail below, CTIA recommends that all spectrum management functions should be performed by the

16/ *See* White Paper at 5.

17/ *See* White Paper at 5.

FCC to avoid duplication and maximize efficiency. Regardless of which agency is responsible for spectrum use, *federal* spectrum management must be improved.

A. Congress Should Consider Requiring That All Spectrum Use Decisions Be Made by the FCC.

Since 2009, CTIA has been at the forefront of efforts to make available additional spectrum for mobile broadband. It applauds the assessments of spectrum use undertaken, and goals for spectrum development that have been set, by the President, Congress, and the FCC. While each of these initiatives has been valuable, they have not been coordinated, comprehensive, or consistent. The President established one set of spectrum goals in two recent memoranda, in which he emphasized the importance of freeing up both licensed and unlicensed spectrum suitable for mobile broadband and also directed federal users to work cooperatively with each other and industry to facilitate commercial entry into key spectrum bands.[18/] In addition, the FCC established a set of spectrum goals in the National Broadband Plan, designed to ensure efficient allocation and use of government assets, make 500 megahertz of spectrum newly available for broadband, and promote greater transparency of spectrum allocation, assignment, and use.[19/] Congress identified similar goals in the Middle Class Tax Relief and Job Creation Act of 2012 ("Spectrum Act"), under which it expressed its preference for reallocating federal spectrum for exclusive, non-federal use and directed the FCC to allocate and license 15 megahertz of contiguous spectrum by February 2015.[20/] Similarly, two entities – NTIA and the

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18/ *See Expanding America's Leadership in Wireless Innovation*, 78 Fed. Reg. 37431 (June 20, 2013) ("2013 Presidential Memorandum"); *Unleashing the Wireless Broadband Revolution*, 75 Fed. Reg. 38385, 38388 (July 1, 2010) ("2010 Presidential Memorandum").

19/ *See Connecting America: The National Broadband Plan*, at xii (2010) ("National Broadband Plan"), *available at* http://www.broadband.gov/plan/.

20/ *See* Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, 126 Stat. 156 (2012) ("Spectrum Act") (codified in various sections of Title 47 of the U.S. Code).

FCC – are responsible for issuing authorizations for spectrum use.[21/] While the two agencies are obligated to coordinate their spectrum management activities,[22/] their efforts have been inconsistent.[23/]

In order to overcome these duplications and inefficiencies, a single entity should be responsible for spectrum policy (establishing national spectrum goals and strategies) and implementation authority (licensing spectrum use). That entity would be charged with, among other responsibilities, comparing and addressing mismatches between spectrum needs for both federal and non-federal users on the one hand and how spectrum is allocated among services today on the other. Finally, it would issue authorizations to all spectrum users, whether federal or non-federal, in order to most effectively implement the strategies it determines to be in the public

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21/ *See* 47 U.S.C. § 305 (preserving for the President the authority to assign frequencies to all federal government-owned or operated radio stations); Reorganization Plan No. 1 of 1970, 35 Fed. Reg. 6421 (April 22, 1970) ("The functions relating to assigning frequencies to radio stations belonging to and operated by the United States, or to classes thereof, conferred upon the President by the provisions of section 305(a) of the Communications Act of 1934, 47 U.S.C. 305(a), are hereby transferred to the Director of the Office of Telecommunications Policy hereinafter provided for."); Reorganization Plan No. 1 of 1977, 42 Fed. Reg. 56101, § 7 (1977) ("All other functions of the Office of Telecommunications Policy and of its Director are hereby transferred to the Secretary of Commerce who shall provide for the performance of such functions."); Executive Order 12046, Relating to the Transfer of Telecommunications Functions, 43 Fed. Reg. 13349 (March 29, 1978) ("The establishment of an Assistant Secretary for Communications and Information, Department of Commerce, as provided by Section 4 of Reorganization Plan No. 1 of 1977, is hereby effective."); U.S. Government Accountability Office, *2012 Annual Report: Opportunities to Reduce Duplication, Overlap and Fragmentation, Achieve Savings, and Enhance Revenue*, GAO 12-342SP, at 90 (Feb. 2012), *available at* http://www.gao.gov/assets/590/588818.pdf ("GAO 2012 Annual Report").

22/ *See generally* 2013 Presidential Memorandum; 2010 Presidential Memorandum; *see also* National Telecommunications and Information Administration Act, title I, §§ 103, 112 (1992) (codified as amended at 47 U.S.C. §§ 902 (b)(2)(L)(i), 922); Memorandum of Understanding Between the Federal Communications Commission and the National Telecommunications and Information Administration (Jan. 31, 2003), *available at* http://www.ntia.doc.gov/files/ntia/publications/fccntiamou_01312003.pdf.

23/ *See* GAO 2012 Annual Report at 90-91 (reporting that that meetings between the FCC and NTIA have not occurred regularly, that the entities have not jointly developed a strategic spectrum plan encompassing federal and non-federal spectrum use, and that NTIA and FCC officials identified different documents when asked which documents comprise the national spectrum strategy).

interest. Such an approach would produce a singular, unified national policy, promoting administrative efficiencies and resulting in more intense spectrum use.

Accordingly, CTIA recommends Congress consider changing NTIA's role so that, consistent with national security concerns, spectrum use decisions are all made by the FCC. Concentrating spectrum policy and licensing authority with the FCC will not diminish federal agencies' access to spectrum needed to fulfill their critical missions. To the contrary, more comprehensive spectrum management can lead to more effective use of spectrum by federal entities, resulting in agencies being better able to fulfill their obligations, including providing for our nation's defense.

Under this redesign, NTIA would still have a critical role to play. It would serve as an advisor to federal agencies and would interface with the FCC to request spectrum on their behalf. Just as personnel at NTIA have appropriate security clearances today to handle sensitive data, personnel at the FCC would be required to secure permission to access protected information. Although Congress need not outline the specific structure under which the Commission should be organized to effectuate this regime, it should ensure that the FCC has the means and authority to implement policies that promote the cycle of investment and innovation that has been the hallmark of the wireless industry.

B. Regardless of the Governing Entity or Entities, Federal Spectrum Management Must Be Improved.

Regardless of whether it is the FCC or NTIA that oversees it, federal spectrum management must be improved. While NTIA issues spectrum authorizations, it does not direct spectrum use in a way that provides incentives – positive or negative – for efficiency. This has several negative consequences. First, it means that federal agencies, including our military, may not be using the most sophisticated technologies available, relying on less efficient and

potentially outdated systems. Second, it means that federal agencies may be using more spectrum than they otherwise require, preventing that spectrum from becoming available for commercial wireless operations, which is essential for the development of innovative wireless services.

CTIA appreciates the efforts already undertaken by Representatives Brett Guthrie (R-KY) and Doris Matsui (D-CA) to promote spectrum efficiencies by providing incentives for federal agencies to vacate unused or under-used spectrum.[24/] As CTIA has stated, reallocation of federal spectrum is critically important and the Federal Spectrum Incentive Act offers a path that can deliver a win for government users, industry, and consumers alike.[25/] Similarly, the Congressional Spectrum Caucus will facilitate dialogues about the importance of spectrum policy and provide stakeholders with a means to identify ways to increase access to and better utilize the nation's spectrum resources.[26/]

Congress should expand on these efforts and ensure that agencies have other incentives to migrate to more efficient technologies. To that end, federal agencies should have access to funding unrelated to spectrum auctions to cover costs, including research and development

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24/ Federal Spectrum Incentive Act of 2013, H.R. 3674, 113th Cong. (2013).

25/ *See* Letter from Steve Largent, CTIA – The Wireless Association®, to Tom Power, Deputy Chief Technology Officer, Telecommunications, Office of Science and Technology Policy, at 4 (filed March 20, 2014) ("CTIA OSTP Comments"), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/rfi_responses_-_fr_doc._2014-03413_filed_2-14-14_all.pdf ("CTIA applauds the sponsors of that legislation, Reps. Brett Guthrie and Doris Matsui, for their forward-thinking proposal. . . . Congress should further investigate other ways by which agencies' budgets can be increased if they make spectrum available for commercial wireless broadband systems."); CTIA Statement on the House Energy & Commerce Committee Approval of the Federal Spectrum Incentive Act and the FCC Process Reform Act (Dec. 11, 2013), *available at* http://www.ctia.org/resource-library/press-releases/archive/spectrum-incentive-fcc-reform-acts ("[The Guthrie-Matsui] bill provides a creative way to repurpose federal spectrum that isn't being utilized or used efficiently and in doing so will help the commercial mobile industry gain access to spectrum it needs to maintain America's place as the world's leader in wireless broadband service.").

26/ *See, e.g.*, Guthrie to Co-Chair Newly-Introduced Spectrum Caucus, News Release (Feb. 27, 2014), https://guthrie.house.gov/latest-news/guthrie-to-cochair-newlyintroduced-spectrum-caucus/.

expenses, related to spectrum relocation, efficiency, and sharing.[27/] Additional research funding would provide federal entities the incentive and ability to investigate and develop more efficient technologies to reduce overall spectrum consumption. While CTIA disagrees with many of the conclusions it reached, the President's Council of Advisors on Science and Technology ("PCAST") was right when it stated that federal agencies may have neither the incentive nor the authority to enhance their use of spectrum if the cost of doing so depletes the budget available for their core missions.[28/] Federal agencies' ability to access money for research and development, however, need not be unrestricted. Instead, those entities should be required to demonstrate how the funds can result in spectrum efficiencies and specify a timeframe by which their efforts can reasonably be expected to lead to spectrum becoming available for other uses.[29/]

III. THE ACT SHOULD CONTAIN CLEAR SPECTRUM GOALS

A. Spectrum Should Be Made Available for Exclusive Commercial Use.

The White Paper points out that there is a vigorous debate over the appropriate role for unlicensed spectrum in the wireless ecosystem, noting that some parties contend that assigning spectrum via exclusive licensing is the most effective, efficient, and economically responsible way to allocate spectrum.[30/] The White Paper therefore asks what role unlicensed spectrum should play in the wireless ecosystem, including how it should be allocated and managed.

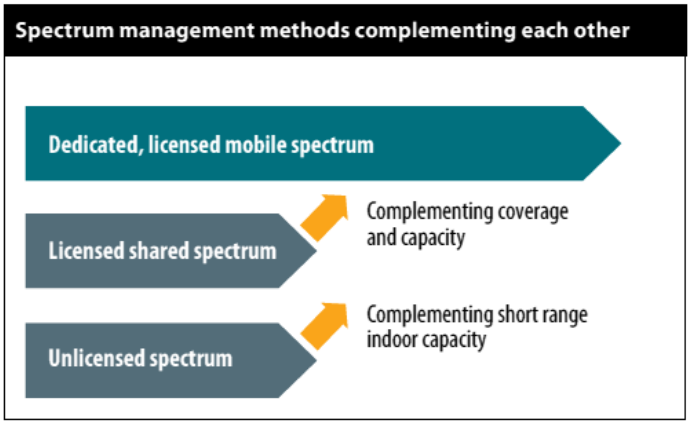
27/ CTIA OSTP Comments at 3-4.

28/ *See* PCAST, *Report to the President: Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth*, at 56-60 (July 2012) ("PCAST Report"), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf; *see also id.* at xv ("As a result, they may decide not to take on the substantial costs of relocating agency systems and operations, expanding shared access to Federal bands, designing or procuring new and upgraded Federal systems, or moving to far more spectrum-efficient and/or interference-tolerant technologies afford.").

29/ CTIA OSTP Comments at 4.

30/ *See* White Paper at 2-3.

CTIA recognizes the importance of unlicensed spectrum, but suggests spectrum allocation for wireless use should foremost consist of dedicated, exclusive spectrum for commercial use. Then, spectrum may be used on a licensed shared basis under appropriate circumstances. Finally, unlicensed spectrum should be made available to complement short-range and indoor needs.[31/]



1. Exclusive Spectrum Must be Preferred.

As CTIA has explained to the Administration and the FCC, there is no substitute for licensed, exclusive-use spectrum.[32/] Indeed, Congress observed as much when it directed NTIA in the Spectrum Act to prioritize reallocation over sharing.[33/] Exclusive licensing creates the certainty necessary for commercial entities to invest and innovate in spectrum. As CTIA previously observed, "[t]he preference for clearing and an exclusive-use approach has fostered

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31/ *See* Ericsson, *The Spectrum Crunch – Busting the Solutions Myth*, at 8 (Dec. 10, 2013), *available at* http://www.ericsson.com/res/thecompany/docs/publications/business-review/2013/the-spectrum-crunch-busting-the-solutions-myth.pdf.

32/ *See* CTIA OSTP Comments at 1-3; Comments of CTIA–The Wireless Association®, GN Docket No. 12-354, at 6-10 (filed Feb. 20, 2013) ("CTIA 3.5 GHz Band Comments").

33/ *See* Spectrum Act § 6701(a)(3), codified at 47 U.S.C. § 923(j) ("In evaluating a band of frequencies for possible reallocation for exclusive non-Federal use or shared use, the NTIA shall give priority to options involving reallocation of the band for exclusive non-Federal use and shall choose options involving shared use only when it determines . . . that relocation of a Federal entity from the band is not feasible because of technical or cost constraints.").

the U.S. wireless industry's world-leading deployment of mobile broadband networks and provided tremendous economic benefits for U.S. consumers and businesses."[34/] To continue investment in technology and infrastructure and growth in the economy, it is critical for commercial carriers to have exclusive use of spectrum.

2. Sharing May be Appropriate in Some Instances.

Where exclusive spectrum is not available, carriers can sometimes share – temporally and geographically – on a licensed basis with government users.[35/] Sharing, however, should generally be used only as an interim measure while the clearing of federal spectrum occurs. As recently noted by Mobile Future, spectrum sharing suffers from many significant challenges that are insurmountable in the near-term.[36/] For instance, spectrum sharing is new, and users are reluctant to invest in unproven approaches.[37/] Moreover, there are a large number of different government systems, use cases, propagation models, security risks, and enforcement mechanisms, among other matters, that must be analyzed when considering spectrum sharing.[38/]

34/ *See* CTIA OSTP Comments at 2; CTIA 3.5 GHz Band Comments at 11; *see also* CTIA, *CTIA Statement on PCAST Government Spectrum Report* (July 20, 2012), *available at* http://blog.ctia.org/2012/07/20/pcast-report/.

35/ *See* Kathryn C. Brown and Charla Rath, *U.S. Spectrum Policy: The Way Forward*, at 4 (Nov. 13, 2012), *available at* http://www.siliconflatirons.com/documents/conferences/2012.11.13%20Spectrum/Compendium.pdf ("Near-term sharing efforts should focus on geographic and temporal sharing, using lessons learned from existing wireless networks. . . . Over the long-term, sharing technologies such as dynamic spectrum access and geo-location based sharing may be worth exploring – but presently such sharing cannot be seen as a substitute for clearing and reallocating spectrum.").

36/ *See* Rysavy Research, LLC, and Mobile Future, *Complexities of Spectrum Sharing: How to Move Forward*, at 15 (Apr. 2014) ("Mobile Future Paper"), *available at* http://mobilefuture.org/wp-content/uploads/2014/04/Spectrum-Sharing-Paper-2014.pdf; *see also* Deloitte, *The Impact of Licensed Shared Use of Spectrum*, at 10 (Jan. 23, 2014), *available at* http://www.deloitte.com/assets/Dcom-UnitedStates/Local%20Assets/Documents/TMT_us_tmt/us_tmt_GSMA_Spectrum_020714.pdf (explaining that there are "many variables involved" with spectrum sharing that "necessitate terms specific to each sharing opportunity" and that "[n]o generalised (sic) approach is possible).

37/ *See* Mobile Future Paper at 15.

38/ *See* Mobile Future Paper at 15-19.

More work is necessary to determine how sharing can be effectively accomplished before it is implemented on a long-term basis.

The White Paper notes that PCAST has concluded that sharing is the most efficient way to utilize spectrum.[39/] However, the approach that PCAST, which contained no representation from actual service providers, took is flawed.[40/] In addition to overstating the utility and effectiveness of sharing, PCAST inappropriately discounts the value and benefits of exclusive-use spectrum as a basis for investment and technology evolution and for providing high-quality, real-time services. As noted above, commercial mobile providers have invested billions of dollars in networks, and the wireless industry's annual contribution to the country's gross domestic product is now valued at $195.5 billion, which is larger than publishing, agriculture, hotels and lodging, air transportation, motion picture and recording, and motor vehicle manufacturing industry segments.[41/] These outcomes are due, in large measure, to the availability of licensed, exclusive-use spectrum.[42/]

If spectrum policy is shifted to accommodate the PCAST recommendations, trials should first be conducted on sharing among federal users, not sharing between federal and non-federal users. It may be easier to first determine compatible uses between federal systems. Moreover, sharing between federal systems may reduce the need to share sensitive information between federal agencies and commercial licensees. In any case, if spectrum sharing is implemented

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39/ *See* White Paper at 3.

40/ *See* CTIA 3.5 GHz Band Comments at 10-12.

41/ *See* CTIA March 2013 Wireless Facts; CTIA, Wireless Quick Facts (last visited April 24, 2014), http://www.ctia.org/your-wireless-life/how-wireless-works/wireless-quick-facts.

42/ *See Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets*, Report and Order and Further Notice of Proposed Rulemaking, 18 FCC Rcd 20604, 20632, ¶ 57 (2003) (crediting existing exclusive, flexible-use bands as being the most intensively used spectrum and as serving as a "runway" for the launch of innovative services).

between federal and non-federal users, it should be directed by an entity that, as CTIA suggests, is responsible for both federal and non-federal spectrum use so that it occurs in a way that best reflects overall U.S. spectrum requirements and priorities.

3. Spectrum Should be Available for Unlicensed Use.

Unlicensed spectrum also has an important role to play in the wireless ecosystem. Wireless carriers often use unlicensed spectrum for, among other purposes, offloading traffic from their networks. As CTIA has previously explained to the FCC, it is in the national interest to make additional spectrum available for both licensed and unlicensed services.[43/]

In determining the appropriate mix of spectrum, Congress should recognize that spectrum that is well suited for mobile broadband services should be reserved for such purposes and licensed for exclusive commercial use. Today, those frequencies lie primarily below 3 GHz.[44/] Where spectrum is not as easily used for mobile wireless services, it could be made available on an unlicensed basis. For instance, Congress has appropriately determined that the 5 GHz band is better suited today for unlicensed operations.[45/] Spectrum policy should continue to recognize

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43/ *See* Letter from Scott K. Bergmann, Vice President, Regulatory Affairs, CTIA, to Ms. Marlene H. Dortch, Secretary, FCC, GN Docket No. 13-185 and WT Docket No. 13-49, at 1 (filed March 24, 2014).

44/ *See* Letter from CTIA, 4G Americas, Consumer Electronics Association, High-Tech Spectrum Coalition, Information Technology Industry Council, Telecommunications Industry Association, and Wireless Broadband Coalition, to Chairmen Upton and Walden and Ranking Members Waxman and Eshoo, Committee on Energy & Commerce, at 2 (Sept. 12, 2012), *available at* http://www.4gamericas.org/documents/120912%20Mulit%20Assoc%20Call%20for%20More%20Licensed%20Spectruml.pdf (explaining that "[m]ore cleared, paired, internationally-harmonized spectrum allocations below 3 GHz are needed and needed soon"); *see also* National Broadband Plan at 84; Department of Defense, *Electromagnetic Spectrum Strategy 2013: A Call to Action*, at 2 (2013), *available at* http://www.defense.gov/news/dodspectrumstrategy.pdf (recognizing that lower frequencies are necessary for mobile communications).

45/ *See* 47 U.S.C. § 1453. Of course, technology changes may make different spectrum appropriate for mobile wireless use in the future, potentially requiring reallocation of spectrum to accommodate mobile wireless requirements.

the differences in various spectrum bands, such as propagation characteristics and coverage capabilities when deciding how to allocate licensed and unlicensed spectrum.

B. Carriers Must Be Able to Deploy Spectrum to Ensure its Effective Use.

Spectrum is only as valuable as carriers' ability to deploy it. Therefore, Congress should make it a clear goal, and direct the FCC, to provide relief from onerous siting rules, particularly for installations that have minimal environmental impact. Specifically, Congress should direct the Commission to take the actions proposed in its recently initiated antenna-siting rulemaking proceeding. There, the Commission requested comment on, among other matters, ways to expedite or tailor its environmental review process for proposed deployments of small cells, Distributed Antenna Systems ("DAS"), and other small-scale wireless technologies.[46/]

As CTIA explained in that proceeding, it generally supports the FCC's efforts to expedite the wireless siting process consistent with congressional directives.[47/] DAS and other small cell facilities, in particular, should be subject to little, if any, review at the federal, state, and local level given their minimal profile and lack of impact.[48/] While Congress has already sought to ease the burdens of infrastructure deployment by adopting Section 6409(a) of the Spectrum Act, which provides that state and local governments must approve certain facilities requests,[49/] that provision does not establish timelines for state and local action. Thus, to the extent that applications for use of DAS and other small cell facilities are subject to review, Congress should clarify that they are subject to the same presumptively reasonable time limits as other personal

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46/ *See Acceleration of Broadband Deployment by Improving Wireless Facilities Siting Policies, et al.*, Notice of Proposed Rulemaking, 28 FCC Rcd 14238 (2013).

47/ *See* Comments of CTIA – The Wireless Association®, WT Docket No. 13-238, *et al.*, at 1 (filed Feb. 3, 2014) ("CTIA Wireless Facilities Comments").

48/ CTIA Wireless Facilities Comments at 21-22.

49/ *See* Spectrum Act § 6409(a).

wireless service facilities and establish timelines for responses from state and local authorities on such applications. In addition, because the existing environmental rules were developed long before small cell technologies became prevalent to reflect the scale and level of environmental concern presented by traditional deployments on tall structures, CTIA supports excluding DAS and small cell deployments from review pursuant to the National Environmental Protection Act and the National Historic Preservation Act.

Similarly, Congress should ensure that other stakeholders take actions – which are already required – to faciliate greater access to federal government property by commercial providers. Congress, for example, directed in Section 6409(c) of the Spectrum Act that the General Services Administration ("GSA"), among other things, develop master contracts to govern the placement of wireless service antenna structures on buildings and other property owned by the federal government.[50/] As a complement to this effort, the President released Executive Order 13616, which directed agencies to "develop and use one or more templates for uniform contract, application, and permit terms to facilitate nongovernment entities' use of Federal property for the deployment of broadband facilities."[51/] This initiative was to be undertaken through a Broadband Deployment on Federal Property Working Group ("Working Group") co-chaired by representatives designated by the Administrator of General Services and the Secretary of Homeland Security from their respective agencies, in consultation with the Director of the Office of Science and Technology Policy and in coordination with the Chief Performance Officer.

50/ *See* Spectrum Act § 6409(c) (requiring GSA to complete that task within 60 days of enactment).

51/ *See* Exec. Order No. 13616, 77 Fed. Reg. 36903 (June 20, 2012).

Despite this clear direction from Congress and the President, little has been done to facilitate wireless carriers' access to federal property. Twenty-six months after enactment of the Spectrum Act, the work needed to effectuate Section 6409(c) is not complete. In "A Progress Report to the Steering Committee on Federal Infrastructure Permitting and Review Process Improvement," the Working Group reported that GSA has developed a common master application, an antenna lessee checklist, master contracts, lease forms, and license forms and presented the forms to the Working Group.[52/] In addition, the report indicated that additional work to streamline the process for deploying broadband infrastructure on federal buildings or property, as required by Executive Order 13616, would be complete, depending on function, in either the third or fourth quarters of 2013. However, the forms developed by GSA are not yet available for wireless carriers' use, and the work performed pursuant to Executive Order 13616 does not appear to be complete yet either. Congress should therefore take additional action to further ensure carriers' access to federal properties.

IV. THE ACT SHOULD PROVIDE THE FCC WITH APPROPRIATE SPECTRUM MANAGEMENT TOOLS

A. Spectrum Should Be Managed By A Single Entity at the FCC.

The White Paper observes that the FCC is responsible for licensing spectrum across several services and that, although many of the processes are the same, its licensing authority is spread across disparate bureaus.[53/] It thus asks what structural changes should be made to the FCC to promote efficiency and predictability in spectrum licensing. The White Paper also notes that, in order to issue spectrum licenses, the Communications Act requires the FCC to make an

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52/ *See Implementing Executive Order 13616: Progress on Accelerating Broadband Infrastructure Deployment*, at 5-6 (Aug. 2013), *available at* http://www.whitehouse.gov/sites/default/files/microsites/ostp/broadband_eo_implementation.pdf.

53/ *See* White Paper at 2.

affirmative finding that granting the license serves the public interest, convenience, and necessity, and seeks comment on what criteria the FCC should consider when conducting this analysis.[54/]

Just as it recommends consolidating the roles of NTIA and the FCC at the Commission, CTIA agrees that spectrum management should be contained in a single bureau at the FCC. A centralized approach to spectrum licensing would streamline the processing of applications and promote other efficiencies. For instance, the new organization could leverage the same technical and legal experts across all radio services. Management of spectrum resources by a single administrative entity would also allow it to best assess efficient spectrum use and opportunities for spectrum reallocation.

In modernizing the Act, CTIA urges Congress to further refine the "public interest" standard used to grant licenses. Both licensees and the Commission would benefit from further development of the criteria which satisfy that standard. Additional clarity could provide applicants with greater certainty in formulating business plans and would expedite FCC review of applications.

B. The FCC Should Issue Flexible Licenses.

The White Paper seeks comment on whether all FCC licenses should allow flexible use, permitting licensees to use their spectrum for any service.[55/] It also asks in what instances the Commission should exercise control over the services that licensees offer.

As a general matter, licensees should be afforded flexibility in the services they offer. The Commission has routinely declined to impose equipment standards or require licensees to

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54/ *See* White Paper at 3.

55/ *See* White Paper at 3-4.

use certain technologies,[56/] and Congress should direct the FCC to continue this practice. Congress should also direct the Commission to refrain from imposing particular service obligations in specified spectrum bands as it did, for example, for the 700 MHz auction. There, the Commission applied special conditions to certain spectrum blocks – the C Block was subject to "open platform" requirements and the D Block was subject to public safety-commercial network partnership requirements.[57/] These blocks were either unsold (the D Block) or were auctioned at a price below the spectrum that was made available for flexible use (the C Block).[58/]

Licensees should be free to offer a variety of services – *e.g.*, voice, data, etc. – so that they are not locked into a particular technology or service as the market and technologies continue to evolve. As CTIA has noted, "[h]istory demonstrates that the public interest is best advanced by the Commission's longstanding flexible-use spectrum policy, which provides licensees the freedom to compete, the opportunity to innovate, and the ability to satisfy evolving consumer demands."[59/] The goal of regulatory policy should be to maximize opportunity, not micromanage outcomes. If the Commission aims to internationally harmonize spectrum use to

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56/ *See, e.g.*, *Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz*, Report and Order, GN Docket No. 13-185, FCC 14-31, ¶ 105 (rel. Mar. 31, 2014) ("*AWS-3 Order*") ("Mandating a particular industry standard such as LTE would hamstring innovation and development and be contrary to the Commission's policy to preserve technical flexibility and refrain from imposing unnecessary technical standards."); *see also Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands, et al.*, Notice of Proposed Rulemaking and Order on Reconsideration, 28 FCC Rcd 11479, ¶ 102 (2013).

57/ *See Service Rules for the 698-746, 747-762 and 777-792 MHz Bands, et al.*, Second Report and Order, 22 FCC Rcd 15289, ¶¶ 202, 395 (2007).

58/ *See Auction of 700 MHz Band Licenses Closes*, Public Notice, 23 FCC Rcd 4572 (2008).

59/ Comments of CTIA – The Wireless Association®, WT Docket No. 07-195 and WT Docket No. 04-356, at 2 (filed July 25, 2008) ("CTIA AWS-2/3 Comments").

avoid unique spectrum allocations, it will foster greater efficiencies in the deployment of mobile services and equipment.[60/]

Where spectrum allocations are made based on a set of service and technical assumptions, the Commission must fully evaluate requests to use that spectrum for other services. As CTIA has explained to the FCC, allowing Mobile Satellite Service spectrum, for example, to be used for terrestrial broadband services requires a holistic examination of numerous issues, including interference, efficient use of spectrum, build-out requirements, and the public interest considerations associated with increased terrestrial rights.[61/] It is important that the benefits associated with new uses of spectrum be balanced against the protection of operations in neighboring bands,[62/] particularly as incumbents have already developed their business plans and operations based on the FCC's existing service rules. Once spectrum is repurposed for a new service, the Commission should ensure that the new service is likewise protected in the future.[63/]

60/ *See* CTIA AWS-2/3 Comments at 47-49.

61/ *See* Comments of CTIA – The Wireless Association®, WT Docket No. 12-70, *et al.*, at 2-3 (filed May 17, 2012) ("CTIA AWS-4 Comments"); *see also* Comments of CTIA – The Wireless Association®, WT Docket No. 12-357, at 2 (filed Feb. 2, 2013) ("CTIA H Block Comments") ("[T]he Commission must act promptly, while at the same time engaging in a holistic, measured approach to spectrum planning); Comments of CTIA – The Wireless Association®, ET Docket No. 14-14 and GN Docket No. 12-268 (filed Mar. 18, 2014) (suggesting that the Commission further investigate concerns raised about co-channel and adjacent-channel interference between television and wireless services in nearby markets as a result of accommodating market variations as it develops a plan for the 600 MHz band).

62/ *See* CTIA AWS-4 Comments at 10; *see also* CTIA H Block Comments at 2 ("Perhaps most importantly, the Commission must carefully evaluate the interference impact of new mobile broadband services in the H Block and develop a technical rules framework that assures all licensees will be fully protected.").

63/ *See, e.g.*, Comments of CTIA – The Wireless Association®, WT Docket No. 08-166 (filed Jan. 25, 2013) (recommending that wireless microphones and other low power auxiliary service operations be cleared from the 600 MHz band, which will be repurposed from broadcast television services to commercial mobile services, due to the interference risk that they pose).

C. The FCC Should Impose Build-Out Requirements That Recognize Unique Circumstances.

The White Paper asks whether the Communications Act should encourage competitive and efficient use of spectrum through the use of build out requirements and operating rules.[64/] It also asks how effectively the Commission has used the tools at its disposal to encourage competition.

The FCC has generally used build-out requirements effectively to promote efficient spectrum use. Those obligations are an effective tool to ensure that spectrum is put to use in a timely manner and to prevent spectrum warehousing. The Act should continue to allow the Commission to impose build-out requirements, but those requirements should be flexible enough to accommodate unique circumstances and unforeseen events. The Commission should, for instance, continue to take into consideration encumbrances such as the need to accommodate federal users, particularly as more spectrum is shared.[65/] In addition, where build-out is hampered by lack of available equipment, or other circumstances beyond a licensee's control, the FCC should remain sympathetic to requests for modifications of its requirements.[66/] The Commission, however, should not be permitted to adopt unprecedented penalties for failing to meet build-out commitments.[67/]

64/ *See* White Paper at 4.

65/ *See, e.g.*, *AWS-3 Order* ¶¶ 135-141 (adopting longer build-out requirements to account for federal impediments to use of the spectrum).

66/ *See, e.g.*, *Wireless Telecommunications Bureau Extends 700 MHz B Block Licensee Interim Construction Benchmark Deadline Until December 13, 2013*, Public Notice, 28 FCC Rcd 4584 (2013) (extending the interim construction deadline for all active Lower 700 MHz band B Block licensees due to their inability to have meaningful access to a wide range of advanced devices); *AWS-3 Order* ¶ 141 ("We also generally agree that if a licensee demonstrates that it is unable to meet a coverage requirement due to circumstances beyond its control, an extension of the coverage period might be warranted.").

67/ *See* CTIA AWS-4 Comments at 16-17.

D. The FCC Should Manage Receivers Only Where Necessary.

Finally, the White Paper points out that the FCC sets limits on transmissions, but does not regulate receivers used by wireless devices to manage interference.[68/] While some parties have proposed receiver standards as a potential interference mitigation solution, others have argued that such a step could result in over-engineering and higher consumer prices. Accordingly, the White Paper seeks comment on the best balance between mitigating interference concerns and avoiding limiting flexibility.

CTIA agrees that the FCC must continue to have the authority to establish regulations governing transmission characteristics to protect adjacent-band and adjacent-area licensees from interference. Receivers, however, have been appropriately regulated by industry standards created through stakeholder consensus, and marketplace forces should continue to be the primary means by which wireless receivers are developed and introduced. As CTIA has demonstrated to the Commission, industry efforts have resulted in receiver performance standards, including blocking and other requirements,[69/] putting the U.S. wireless industry at the forefront of developing and deploying some of the most interference-resistant receivers in the world. Moreover, there are at least 32 different device manufacturers offering over 630 different handsets and devices in the U.S.[70/] In this competitive environment, device manufacturers that create low-quality products that are subject to excessive interference from others will simply be unable to maintain their operations.

68/ *See* White Paper at 4-5.

69/ *See* Comments of CTIA – The Wireless Association®, ET Docket No. 13-101, at 2 (filed July 22, 2013) ("CTIA TAC Comments").

70/ *See* CTIA TAC Comments at 2.

On the other hand, CTIA recognizes that receiver performance is not fully embraced by all spectrum users. If industry actions and market forces do not result in appropriate receiver characteristics, the FCC may wish to act as a facilitator of multi-stakeholder groups to promote those efforts. CTIA has a wealth of experience with multi-stakeholder groups and thus is a strong supporter of their use.[71/]

Use of a "harms claim thresholds" approach, which relies on multi-stakeholder groups, provides a particularly promising potential framework for encouraging enhanced receiver performance where natural, market-based incentives have failed.[72/] The proposal, developed by the Commission's Technical Advisory Committee ("TAC"), sets forth interference limits that a service would be expected to tolerate from other services before a claim of harmful interference could be made. Multi-stakeholder groups would investigate the interference limits policy at suitable high-value inter-service boundaries, and could modify harm claim thresholds over time. Manufacturers and operators would then be left to determine whether and how to build receivers that could tolerate such interference. Congress should therefore direct the Commission to further examine this approach, but ensure that it is used only when other methods have failed.

V. CONCLUSION

CTIA appreciates and supports the Committee's efforts to review and modernize the Nation's spectrum policies. While the U.S. wireless industry has led the world under the current statutory regime, Congress can promote further growth and investment by ensuring that spectrum

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71/ *See, e.g.*, CTIA TAC Comments at 7-8; *see also* Comments of CTIA – The Wireless Association®, IB Docket No. 11-109, at 3 (filed Feb. 27, 2012) ("CTIA submits industry and government stakeholders should work together in these efforts to advance receiver performance to maximize spectral efficiency.").

72/ *See* CTIA TAC Comments at 4-7.

is comprehensively and well managed to meet industry needs. CTIA stands ready and looks forward to working with the Committee on these important endeavors.

April 25, 2014

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April 25, 2014

The Honorable Fred Upton
Chairman
Committee on Energy and Commerce
House of Representatives
Washington, DC 20515

The Honorable Greg Walden
Chairman
Subcommittee on Communications and Technology
House of Representatives
Washington, DC 20515

Re: Modernizing U.S. Spectrum Policy

Dear Chairman Upton and Chairman Walden:

Thank you for the opportunity to comment on the issue of modernizing U.S. spectrum policy.[1]

I. WHAT ROLE SHOULD UNLICENSED SPECTRUM PLAY IN THE WIRELESS ECOSYSTEM?

Technologies that use unlicensed spectrum, such as Bluetooth and Wi-Fi, have been hugely successful, and Wi-Fi has played a very important backup role permitting the offloading of traffic from congested networks that operate in licensed spectrum. Both licensed and unlicensed users urgently require access to more spectrum. The challenge for policymakers is to fairly and efficiently allocate more spectrum between the two.

The principal justification for unlicensed spectrum is that it does provide a secondary outlet for innovation. The Wireless Innovation Alliance observes on it's website that

> Unlicensed spectrum is unique in that its availability has provided a crucial platform for "innovation without permission." This kind of innovation stems from low barriers to entry, the ability to experiment and collaborate, the

> deployment of open standards, and the creation of multi-layer competition, all of which allow anyone to bring low-cost products and services to market.[2]

On the other hand, exclusive licenses with renewal expectancies have helped wireless service providers attract billions of dollars of private capital to construct extensive network capacity and to compete based on quality of service and ability to satisfy the surging demand for affordable bandwidth. Peter Rysavy, for example, doubts that anyone could raise a comparable amount of private capital to build infrastructure for using unlicensed spectrum.

> It is extremely unlikely that any entity will invest billions of dollars in massive amounts of network infrastructure to use unlicensed spectrum to support commercial wireless broadband services. The carrier's inability to guarantee service quality, predict and manage capacity, and eliminate or prevent interference render unlicensed spectrum an inferior solution for providers who compete based on quality of service and ability to support bandwidth-hungry apps and devices.[3]

Access to unlicensed spectrum comes with "no guarantees as to the quality of service available," since users enjoy scant protection against interference from other licensed or unlicensed users.[4] Although—as the Commerce Spectrum Management Advisory Committee has observed—improved technology may "mitigate interference and organize spectrum usage such that [unlicensed] quality of service may equal and, in some instances, surpass licensed services that do not use these techniques,"[5] the technology has not been fully developed and tested, let alone implemented and proven in the marketplace. Moreover, as CSMAC concedes, licensed uses that do use the same techniques may nevertheless continue to offer superior quality of service.

Therefore, while government should allocate sufficient unlicensed spectrum for experimental purposes, beyond that it should allocate as much spectrum as possible for licensed uses. As long as unlicensed uses would preclude licensed uses that are more valuable, Evan R. Kwerel's and John R. Williams' observation that government is not well-equipped for determining the highest and best use for spectrum remains valid. As they wrote in a 1998 paper,

> Unlicensed use may be justified for a limited amount of spectrum because such use has the characteristics of a public good. It may not be efficient to license or charge for entry if one person's use does not significantly contend with an other's. That arrangement normally requires sharing protocols and accepting severe limitations on transmitter power and range. Because such restrictions preclude valuable licensed uses, determining the appropriate amount of spectrum to allocate for unlicensed use would require a cost-benefit analysis. In practice, administrative agencies find it difficult to conduct such analyses and will end up

> assigning an arbitrary amount of spectrum to such uses. Further, holders of exclusive spectrum licenses may be able to provide similar services by charging a license fee to manufacturer's of low-power devices that operate on their spectrum or by limiting use of the spectrum to low-power devices that they manufacture. Although the process may result in a suboptimal allocation of spectrum, that allocation may not necessarily be worse than an administratively determined one.[6]

In other words, there is a disinclination for policymakers to conduct the rigorous economic analysis that would be necessary to determine where spectrum is needed most—if it is even possible to do it accurately—and a temptation to yield to political pressures or ideological preferences. Spectrum auctions can be criticized on a number of grounds, but as the history of the "beauty contest" and the lottery shows, nothing is more fair or rational than auctioning.

Technologies such as Wi-Fi and LTE could care less whether the frequency bands within which they were designed to operate are licensed or unlicensed. Kevin Werbach and Aalok Mehta suggest that the licensed versus unlicensed debate is beside the point.

> Both approaches have a place, but they represent two ends of a continuum of sharing. A frequency can be licensed and still shared, for example, if licenses are limited in the scope of the rights they grant. Similarly, unlicensed allocations can be designed to occupy an entire band, as with WiFi, or structured to coexist with other systems.

Werbach and Mehta posit that "The real question is whether the baseline assumption of spectrum policy should lean toward exclusivity or sharing."[7] Fortunately, with flexible spectrum rights, this is a question that buyers and sellers could decide for themselves when it makes sense—not *before* or *after*, as is usually the case when the FCC decides.

II. SHOULD ALL FCC LICENSES BE FLEXIBLE USE?

The answer is yes. If, for example, broadcasters had the flexibility to sell their rights to use spectrum, Congress and the FCC would not have to be in the position of setting up complicated reverse auctions. Similarly, if federal agencies could sell their spectrum rights, Congress wouldn't have to struggle to find a way of breaking up the vast inventories of unutilized or underutilized spectrum in the hands of government agencies that have "no incentives" to use it efficiently or share it.[8] Inflexible license terms foster inefficiency and threaten innovation as well as the nation's competitiveness.

III. WHAT PRINCIPLES SHOULD CONGRESS AND THE FCC CONSIDER WHEN ADDRESSING SPECTRUM AGGREGATION LIMITS? HOW HAS THE CONVERGING MARKETPLACE AND GROWING DEMAND FOR SERVICES CHANGED THE DISCUSSION OF SPECTRUM AGGREGATION?

There's no need any longer for arbitrary spectrum aggregation limits, which originated during the industry's formative stages when it was broadly deregulated by Congress and the FCC. The commission established a spectrum cap in 1994 to guard against the possibility of dramatic and unwarranted price increases.

> If firms were to aggregate sufficient amounts of spectrum it is possible that they would unilaterally or in combination exclude efficient competitors, reduce the quantity or service available to the public, and increase prices to the detriment of consumers. We believe that the imposition of a cap on the amount of spectrum a single entity can control in an area will limit the ability to increase prices artificially.[9]

At the time, it cost an average of almost 50 cents a minute to make a voice call.[10] By 2001, average voice revenue per minute had fallen to slightly over 12 cents.[11] That year, the commission voted to let the cap sunset effective Jan. 1, 2003.[12] "Consumer watchdogs and some legislators argued that raising or eliminating the caps would spark a wave of mergers that would reduce competition, discourage innovation and raise prices," according to a news report.[13] Yet by 2011 (the most recent year for which the FCC has published these statistics) revenue per minute was less than five cents.[14]

The sunset of the spectrum cap did not leave the mobile wireless market "exposed and susceptible to anti-competitive behavior or harmful consolidation," just as Assistant Secretary of Commerce Nancy J. Victory predicted it would not in 2001.

> As many commenters in this proceeding have recognized, the Department of Justice (DOJ) and the Commission both have mechanisms in place for reviewing and addressing potentially anti-competitive consolidation. Indeed, as the primary enforcer of the antitrust laws, the DOJ routinely reviews communications transactions for harmful competitive effects. The Commission engages in a similar analysis when it reviews proposed transactions for consistency with the public interest. These safeguards are more than sufficient to protect against future anti-competitive conduct or consolidation that threatens the public interest.[15]

The current FCC chairman argues that it's unfair AT&T and Verizon Wireless have more low-frequency spectrum (below 1 GHz) than Sprint or T-Mobile.[16] But Chairman Wheeler is looking in a rear view mirror. Not only is the relative importance

of low-frequency spectrum plummeting, but the robust high-frequency portfolios belonging to Sprint and T-Mobile may be a blessing in disguise.

"The benefits of lower frequencies are overstated," explains Peter Rysavy. "Essentially, technology will enable more beachfront spectrum."[17] That's because smart antennas such as Multiple Input/Multiple Output (MIMO) promise to significantly expand radio capacity, throughput, coverage, and cell-edge performance. MIMO is particularly suited for higher frequencies. In fact, Rysavy estimates that within five years MIMO systems could "deliver double the capacity for the same amount of spectrum in systems operating above 2 GHz compared with systems operating below 1 GHz."

The President's Council of Advisors on Science and Technology (PCAST) similarly notes that the move toward higher frequencies and smaller cell sizes "is an important development, already under way."[18]

> The use of smaller cells makes it easier to "reuse" a given frequency for geographically separated services, which linearly increases the aggregate bandwidth available to users by increasing the number of access points in a given area … Smaller cell sizes require more equipment, but with the rapid decline in the cost of wireless devices and the improved availability of highspeed backhaul this is becoming less of an issue.[19]

It also concludes that the implementation of small cells "could make higher frequency spectrum the next 'beachfront' spectrum, since wireless infrastructure is now less commonly being 'built out' for wide area coverage but is instead being 'in built' for higher aggregate capacity."[20]

Chairman Wheeler has also expressed concern that companies already possessing low-band spectrum could "exploit the auction to keep competitors from accessing the spectrum necessary to provide competition." As the Department of Justice has explained,

> the private value [of spectrum] for incumbents in a given locale includes not only the revenue from use of the spectrum but also any benefits gained by preventing rivals from eroding the incumbents' existing businesses. The latter might be called "foreclosure value" as distinct from "use value."[21]

This antitrust theory ignores the possibility that non-dominant firms would place an equal value on eroding the incumbents' existing businesses, and that non-dominant firms could leverage the regulatory process to achieve their objective. Such an outcome could result in a suboptimal allocation of spectrum, as here, where the two competitors that have legitimately attracted the most customers arguably face the most acute

spectrum shortages and face the prospect of network congestion that could degrade the service they provide.

IV. WHAT ROLE SHOULD NTIA PLAY IN THE LICENSING AND MANAGEMENT OF SPECTRUM?

An independent agency made sense when spectrum licenses were awarded on the basis of comparative hearings. However, spectrum auctions are a relatively straightforward process. Aside from that, the only thing that's really needed today is a spectrum registrar, and it's difficult to see how an administratibve agency such as NTIA does not already have (or could not easily acquire) the expertise to perform such a task. The FCC was modeled after the Interstate Commerce Commission, and the FCC's comparative hearings were like the processes the ICC used to award trucking routes and the Civil Aeronautics Board used to award routes to airlines. The FCC has decreased in significance just like the ICC and the CAB as a result of technological progress and the competition that innovation enabled. Congress phased out both the ICC and the CAB by assigning their functions to administrative agencies within the Executive Branch where necessary. Congress should follow the same approach with respect to the FCC.

* * *

Thank you very much for the opportunity to submit these views, which are my own and do not necessarily reflect the personal views of the officers or fellows of the Discovery Institute.

Sincerely,

Hance Haney
Senior Fellow & Director
Technology & Democracy Project
Discovery Institute

[1] "Committee Releases #CommActUpdate White Paper Focused On Spectrum Policy" [Press release], *Energy & Commerce Committee, United States House of Representatives* (April 1, 2014), *available at* http://energycommerce.house.gov/press-release/committee-releases-commactupdate-white-paper-focused-spectrum-policy.

[2] "Spectrum Policy: Licensed v. Unlicensed," *Wireless Innovation Alliance* (accessed Apr. 25, 2014)

available at http://www.wirelessinnovationalliance.org/index.cfm?objectid=738479B0-7A7C-11E0-A826000C296BA163.

[3] "White spaces networks are not 'super' nor even Wi-Fi," by Peter Rysavy, *Gigaom* (Mar. 17, 2013) *available at* http://gigaom.com/2013/03/17/white-spaces-networks-are-not-super-nor-even-wi-fi/.

[4] "Report to the President: Realizing The Full Potential of Government-Held Spectrum To Spur Economic Growth," *Executive Office of the President, President's Council of Advisors on Science and Technology* (Jul. 2012) *available at* http://m.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf, 2-3

[5] "Final Report of the Unlicensed Uses Subcommittee," *Commerce Spectrum Management Advisory Committee, U.S. Department of Commerce* (Jan. 11, 2010) available at http://www.ntia.doc.gov/report/2011/final-report-unlicensed-uses-subcommittee.

[6] Evan R. Kwerel and John R. Williams, "Free the Spectrum: Market-Based Spectrum Management," *Regulators' Revenge: The Future of Telecommunications Deregulation.* Ed. Tom W. Bell and Solveig Singleton (Cato Inst. 1998), pp. 101-111.

[7] "The Spectrum Opportunity: Sharing as the Solution to the Wireless Crunch," by Kevin Werbach and Aalok Mehta, *International Journal of Communication*, vol. 8 (2014), Feature 128–149, *available at* http://ijoc.org/index.php/ijoc/article/view/2239/1054.

[8] PCAST, *supra note 5*, ix, xv.

[9] Implementation of Sections 3(n) and 332 of the Communications Act – Regulatory Treatment of Mobile Services (GN Docket No. 93-252), *Third Report and Order,* 9 FCC Rcd. 7988, 8100 ¶ 248.

[10] Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993 – Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services (WT Docket No. 11-186), *Sixteenth Report* (rel. Mar. 21, 2013) *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-13-34A1.pdf, Table 38

[11] *Id.*

[12] "FCC Announces Wireless Spectrum Cap To Sunset Effective January 1, 2003" [Press release], *Federal Communications* Commission (Nov. 8, 2001) *available at* http://transition.fcc.gov/Bureaus/Wireless/News_Releases/2001/nrwl0129.html.

[13] "FCC Gives Wireless Mergers a Tip o' the Spectrum Cap," by Tim Kridel, *PCMag* (Nov. 9, 2001) *available at* http://www.pcmag.com/article2/0,2817,107593,00.asp.

[14] *Sixteenth Report, supra note 10.*

[15] In the Matter of 2000 Biennial Regulatory Review – Spectrum Aggregation Limits for Commercial Mobile Radio Services (WT Docket No. 01-14), *NTIA Letter on Spectrum Aggregation Limits For Commercial Mobile Radio Services* (Oct. 24, 2001) *available at* http://www.ntia.doc.gov/fcc-filing/2001/ntia-letter-spectrum-aggregation-limits-commercial-mobile-radio-services.

[16] "Getting the Incentive Auction Right," by Tom Wheeler, FCC Chairman, *Official FCC Blog* (Apr. 18, 2014) *available at* http://www.fcc.gov/blog/getting-incentive-auction-right.

[17] "Learn how technology will turn less desirable airwaves into 'beachfront' spectrum," by Peter Rysavy, *Gigaom* (Jun. 28, 2013) *available at* http://gigaom.com/2013/06/28/learn-how-technology-will-turn-less-desirable-airwaves-into-beachfront-spectrum/.

[18] PCAST, *supra note 5,* 17

[19] *Id.*

[20] *Id.*,19

[21] In the Matter of Economic Issues in Broadband Competition – A National Broadband Plan for Our Future (GN Docket No. 09-51), *Ex Parte Submission of the U.S. Dept. of Justice* (Jan. 4, 2010) *available at* http://www.justice.gov/atr/public/comments/253393.htm.

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DSA
DYNAMIC • SPECTRUM • ALLIANCE

To: House Energy and Commerce Committee

From: Dynamic Spectrum Alliance

Date: April 25, 2014

Re: **White Paper: Modernizing U.S. Spectrum Policy**

About the Dynamic Spectrum Alliance

The Dynamic Spectrum Alliance (DSA) is a global, cross-industry alliance focused on increasing dynamic access to unused radio frequencies and creating innovative solutions to benefit consumers and businesses alike. The membership spans multinational companies, small-and-medium-sized enterprises, academic, research, and other organizations from around the world. A list of members is available at www.dynamicspectrumalliance.org.

Introduction

Usage of wireless networks both in the United States and globally is skyrocketing. The Cisco Visual Networking Index predicts that mobile IP traffic globally will increase eleven-fold over the next five years, and traffic from wireless devices will constitute the majority of all IP traffic by 2016.[1] Meeting this wireless demand is essential to promoting technological innovation and economic growth. To enable the next wave of innovation in the wireless sector and in the broader U.S. economy and to address growing consumer demand for voice, video, and data applications, the House Energy and Commerce Committee (Committee) should support policies that enable robust access to hundreds more megahertz of both unlicensed and licensed spectrum both above and below 1 GHz and that enable dynamic spectrum sharing as a way of improving spectrum utilization.

1. Congressional policies should enable robust access to both licensed and unlicensed spectrum.

[1] *See* Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update: Forecast and Methodology, 2013–2018, http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html; Cisco Visual Networking Index: Forecast and Methodology, 2012–2017 at 1-2 (May 29, 2013), *available at* http://www.cisco.com/c/en/us/solutions/collateral/service-provider/ip-ngn-ip-next-generation-network/white_paper_c11-481360.pdf.

Enabling access to both licensed and unlicensed spectrum is key to meeting increasing spectrum demands. In the past, a balanced approach has fueled the wireless economy, benefiting consumers, innovators, and investors. Exclusive access to licensed spectrum provides the certainty major operators need to make large investments in their wide-area networks, while broad eligibility for access to unlicensed spectrum fosters widespread contributions to innovation and investment in emerging technologies. For instance, because unlicensed devices are "free from the burden of normal delays associated with the licensing process," manufacturers can design equipment to "fill a unique need [that can] be introduced into the market quickly."[2] Thousands of new unlicensed devices are certified each year. Wi-Fi devices are the best known, but Bluetooth,[3] Zigbee,[4] and RFID[5] devices have all also experienced rapid growth in the last several years. Machine-to-machine technologies, which often rely on unlicensed spectrum, represent a large and growing market as well.

Unlicensed use also complements licensed use. For example, "the availability of Wi-Fi networks in many locations . . . enable[s] users to take much of their data off of a licensed network," benefiting users by enabling faster service and reducing congestion for licensed operators.[6] For smartphones and tablets in particular, Cisco has found that "daily data consumption over Wi-Fi is four times that of cellular."[7] This ability to offload data from cellular networks to Wi-Fi has saved mobile network operators billions of dollars in network deployment costs.[8] The Wi-Fi experience also makes clear that greater availability of unlicensed spectrum increases both demand for and the utility of licensed spectrum. Wi-Fi availability has enabled consumers to use their phones and tablets more intensively to access online content and services. Use and development of these online services in turn drives demand for licensed and unlicensed network access, creating a virtuous cycle of investment in content, services, and applications.

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[2] Kenneth R. Carter, Ahmed Lahjouji, & Neal McNeil, FCC, *Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues*, OSP Working Paper Series at 5 (May 2003).

[3] Bluetooth is a standard facilitating hands-free operation of music players, mobile phones, and other devices.

[4] Zigbee powers technologies that benefit from ad hoc and mesh networking solutions, such as home automation.

[5] Radio Frequency Identification (RFID) technologies are used in a variety of industries to track inventory or other objects.

[6] Federal Communication Commission, *The National Broadband Plan* 95 (2010), *available at* www.broadband.gov.

[7] *Id.* at 20.

[8] Mark Cooper, Efficiency Gains and Consumer Benefits of Unlicensed Access to the Public Airwaves, at iii, 15-18 (Jan. 2012) (finding that offloading lowers operator costs by approximately $26 billion per year); European Commission, *Study on the Importance of Wi-Fi & the Socioeconomic Benefits of Using Small Cell Infrastructures*, Aug. 1, 2013, *available at* http://ec.europa.eu/digital-agenda/en/news/study-importance-wi-fi-socioeconomic-benefits-using-small-cell-infrastructures, at 5 (finding that offloading reduced the network costs of European network operators by 35 billion euros in 2012, with savings expect to rise to as much as 200 billion euros in 2016).

In addition, unlicensed spectrum has proven essential to enable Wireless Internet Service Providers (WISPs) to provide fixed and nomadic voice, video, and data services to consumers located remote areas of the country.[9] Wireless backhaul will also play a major role in the deployment of new LTE small cell services nationwide.[10]

For all these reasons, federal policy should support robust access to both licensed and unlicensed spectrum at a variety of high, medium, and low frequencies. Just as licensed and unlicensed access are complementary means of meeting growing spectrum demand, access to spectrum at different frequency ranges is essential to meeting users' varied needs. Lower frequencies enable non-line-of-sight transmission over longer distances, through walls, foliage, and other obstructions. Higher frequencies are ideal for greater transmission capacity over short distances. With a variety of licensing approaches over a range of frequencies, hardware developers and service providers can better and more cost-effectively meet the needs of businesses and consumers, and use spectrum more efficiently.

2. Congress should encourage dynamic spectrum sharing to meet increased demand.

Given the rapidly increasing demand for spectrum to support wireless services, policymakers will not be able to meet urgent needs solely through clearing and repurposing spectrum.

Spectrum sharing is an attractive supplement to spectrum clearing for several reasons. First, spectrum sharing allows efficient use of spectrum. For example, as the FCC has recognized through its efforts to open up the television white spaces for unlicensed use and its proposal to enable spectrum sharing in the 3.5 GHz band,[11] sharing does not displace existing users; it allows new devices and services to take advantage of spectrum that otherwise would be unused. Spectrum sharing strategies, such as dynamic frequency sensing, geo-location databases, and other techniques, thus make the most of a limited resource.

Second, spectrum sharing can make additional spectrum for wireless services available relatively quickly. The process of clearing incumbents and auctioning exclusive licenses can be lengthy and complicated. Spectrum sharing minimizes delays by leaving incumbent operations in place. Further, spectrum sharing can be utilized in times of transition between clearing and auctioning—for example, databases can enable temporary access to available spectrum before

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[9] *See* Comments of the Wireless Internet Service Providers Association, *Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, as Amended by the Broadband Data Improvement Act*, GN Docket No. 12-228 (filed Sept. 20, 2012), *available at* http://apps.fcc.gov/ecfs/document/view?id=7022017891

[10] David Chambers, *Using Unlicensed Spectrum for Small Cell Backhaul*, Mar. 13, 2014, http://www.thinksmallcell.com/Backhaul/using-unlicensed-spectrum-for-small-cell-backhaul.html.

[11] *See generally* Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, Docket No. 12-268, *Notice of Proposed Rulemaking*, 27 FCC Rcd 12357 (2012) (Incentive Auction NPRM); Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354, *Notice of Proposed Rulemaking*, 27 FCC Rcd 15594 (2012).

new licensed services become operational.[12] This flexibility has been demonstrated recently in the Philippines, where the Philippine Government has deployed TV white space radios and connectivity in aid of earthquake and typhoon recovery in Bohol and Tacloban, respectively.[13]

Third, spectrum sharing is proven. Networks relying on shared spectrum have been deployed successfully in the United States.[14] In South Africa, Google's Cape Town trial delivered broadband over vacant broadcast spectrum with a minimum data rate of 2.5 Mbps and peak data rates of 10 Mbps to 10 secondary schools at distances between 3 and 6 kilometers of a base station, without causing harmful interference to incumbent services. Similar and even better performance measurements have been observed in other trials around the world, in locations as diverse as the United States, the United Kingdom, Singapore, Japan, Korea, the Philippines, Kenya, Tanzania, and Malawi. Importantly, these spectrum sharing trials and pilots around the world have achieved excellent performance without causing any harmful interference to incumbent licensees.

****

As the Committee considers potential updates to its spectrum policies, it should consider those policies' long-term economic impact. Spectrum policies will remain with us for years to come, while technology and innovation are constantly changing. Over the course of the last several decades, there are abundant examples of the tremendous economic growth created through innovation and entrepreneurship when new unlicensed spectrum is made available. The best policies are those that invite and enhance such innovation, economic growth, and competition across wireless applications, devices, and services.[15]

In summary, in order to enable continued growth and innovation in wireless technologies and in the U.S. economy as a whole, we urge the Committee to support policies that increase the amount of unlicensed and licensed spectrum available for wireless use. In particular, the Committee should enable unlicensed and licensed spectrum both above and below 1 GHz and support dynamic spectrum sharing as a way to make the most of this finite resource. We look forward to working together on policies that power tomorrow's wireless economy.

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[12] *See* Michael Calabrese, *Use it or Share it: Unlocking the Vast Wasteland of Fallow Spectrum* (2011), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1992421; *see also* Incentive Auction NPRM at ¶ 405.

[13] *See, e.g.*, Pia Ranada, *TV White Space connects Bohol fisherfolk to the Net*, Rappler, Apr. 7, 2014, *available at* http://www.rappler.com/nation/54742-tv-white-space-fisherfolk-bohol.

[14] Amar Toor, *North Carolina launches FCC-approved TV White Space network in Wilmington*, Engadget, Jan. 30, 2012, http://www.engadget.com/2012/01/30/north-carolina-launches-fcc-approved-tv-white-space-network-in-w/

[15] In making policy, the Committee should also recognize that sufficient access to shared or unlicensed spectrum is a critical precondition for successful deployment, just as sufficient access to spectrum is a precondition for the development of licensed services. Device and chip manufacturers hesitate to commit resources to new bands and technologies until there is certainty that sufficient spectrum will be available.

Respectfully submitted,

H. Sama Nwana
Executive Director
Dynamic Spectrum Alliance

ENTROPY ECONOMICS
GLOBAL INNOVATION + TECHNOLOGY RESEARCH

BRET SWANSON
PRESIDENT

April 25, 2014

The Honorable Fred Upton
Chairman
House Committee on Energy and Commerce
2125 Rayburn House Office Building
Washington, D.C. 20515

The Honorable Greg Walden
Chairman
House Subcommittee on Communications and Technology
2125 Rayburn House Office Building
Washington, D.C. 20515

Dear Chairmen Upton and Walden:

Thank you for the opportunity to respond to your request for comments on **wireless spectrum** in the context of an Update of Communications Law.

Mobile and wireless networks are a central driver of innovation and economic growth in the U.S., and around the world. Increasingly, the computer and Internet revolutions are mobile. But scarce spectrum — and the lack of a healthy pipeline — is now limiting the ability of our wireless network operators, device makers, and application creators to move as fast as they (and we) would like.

If we want to accommodate existing demand and encourage the next generations of wireless devices, applications, and services, we need to unleash large swaths of un- and under-used spectrum across a range of frequencies. Most immediately, we need to complete a successful incentive auction of the 600 MHz airwaves. We should then move quickly to free or share spectrum that is held, but not used, by the government.

I have attached five items that address (1) the astounding growth of wireless technologies and the general need to free more spectrum for commercial and private use; and (2) the more specific need for free and open spectrum auctions that ensure as much spectrum as possible flows to its highest value uses.

Please don't hesitate to call on us if we can be of service.

Sincerely,

Bret T. Swanson

Can Spectrum Policy Match Speed of Mobile Expansion?

> *Mobile devices, data traffic roar ahead . . . but spectrum lags*
> *The fundamental computer market shift – from PC to mobile + cloud*
> *Can secondary spectrum markets fill the near term capacity gap?*

BRET SWANSON > July 27, 2012

At the beginning of 2011, Cisco projected mobile data traffic for the year would grow at a sizzling 131%. It was wrong. Mobile traffic last year grew 133%.

Just a decade ago, cell phones were for talking; there was hardly such a thing as "mobile data." At 597 petabytes per month, however, *mobile* data traffic in 2011 was roughly equal to the entire global Internet of 2004.

The rapid expansion of our mobile ecosystem is a boon to consumers and the economy. But it is a daunting challenge for infrastructure providers – and for policymakers. Any market changing so fast exhibits growing pains. New capacity (i.e., more bandwidth) fuels innovation in devices and multimedia content, which in turn hunger for more capacity. Massive private investment in new network capacity has driven and (mostly) accommodated bandwidth demand, which has been more than doubling each year. No business or industry, however, can function smoothly if one of its chief inputs is unavailable. In the case of mobile, that crucial input is wireless spectrum.

"Spectrum" refers to bands of electromagnetic radiation, defined by frequency (and wavelength), ranging from radio waves to visible light to gamma rays. Because of the supreme regularity of electromagnetic radiation, it is highly useful for sensing our world (radar, our eyes, and x-ray machines each "see" different spectrum bands). It is also the most effective means we have found to transmit information – TV, radio, satellite, mobile, Wi-Fi, and much more.

There is no shortage of spectrum, *per se*. It is a fact of nature, revealed by science and harnessed by technology. Yet there is only a relatively small range of spectrum that is useful for mobile communications – and within that range only small portions that the government makes available for commercial use. Today, we don't have the optimal spectrum allocation to encourage continued growth of the Internet economy.

Capacity

When we first started building 3G mobile networks in the mid-2000s, many thought it a silly and wasteful exercise. How would we ever use this capacity? Too much bandwidth at too much expense, not nearly enough applications and services. Mobile device screens were thought too small and too lifeless to watch video, surf the Web, or read, not to mention play games or video chat. There were no mobile "apps" as we know them today.

Just a few short years later, a 2011 Credit Suisse survey of U.S. wireless carriers found their networks running at 80% of capacity, meaning many network nodes are tapped out. The projected unusable surplus of 3G wireless capacity had, thanks to the iPhone and its smartphone cousins, turned into a severe shortage in many big cities.

Fortunately, we can invest in more capacity by building more cell towers and upgrading to

faster wireless networks, such as the new fourth generation (4G) technology known as LTE.

Spectrum, however, is still the foundational resource. And one might say there is a man-made shortage of it. Of the best airwaves between 174 MHz and 4 GHz – the spectrum most useful for mobile communications – the U.S. government claims around 61%. Broadcasters from the over-the-air TV era control around 29%, leaving just about 10% for mobile service providers.

Many policymakers understand this mismatch between our old-world spectrum allocation and the growing needs of our modern mobile ecosystem. Yet there is much evidence that policy is not moving fast enough to sustain investment and innovation. Powerful forces in technology are demanding swifter action.

The New Computers

Mobile phones have been with us since the 1980s. Smartphones and tablets, however, are a fundamental shift in the computer market. This transformation can be seen most vividly in a now-famous chart produced by Asymco (see next page). Using data initially compiled by Jeremy Reimer, Asymco shows annual unit volumes of computing devices since 1975. After lots of new products and jostling in the early and mid-1980s, the market condensed around two basic platforms – PCs and Macs. By the early 1990s, most of the competing devices had died, leaving PCs as the totally dominant computing platform, with Macs a distant second. This duo continued its virtual 100% share through the late 80s, all of the 90s, and most of the 2000s.

Then, in the late 2000s, came the first genuinely new consumer computing platforms in a generation. General purpose in nature, smartphones and, later, tablets had real computer power, broadband connectivity, high end graphics, and supported a wide array of software apps.

The unit volumes achieved by these wireless devices in just a few short years are astounding:

- Smartphones outsold PCs for the first time in 2011 – 488 million versus 415 million units, respectively.
- Sales of tablet computers in 2011 grew 256% to nearly 73 million.
- Non-handset mobile devices, such as tablets and other form-factors, are expected to grow at a 40% compound rate through 2014.

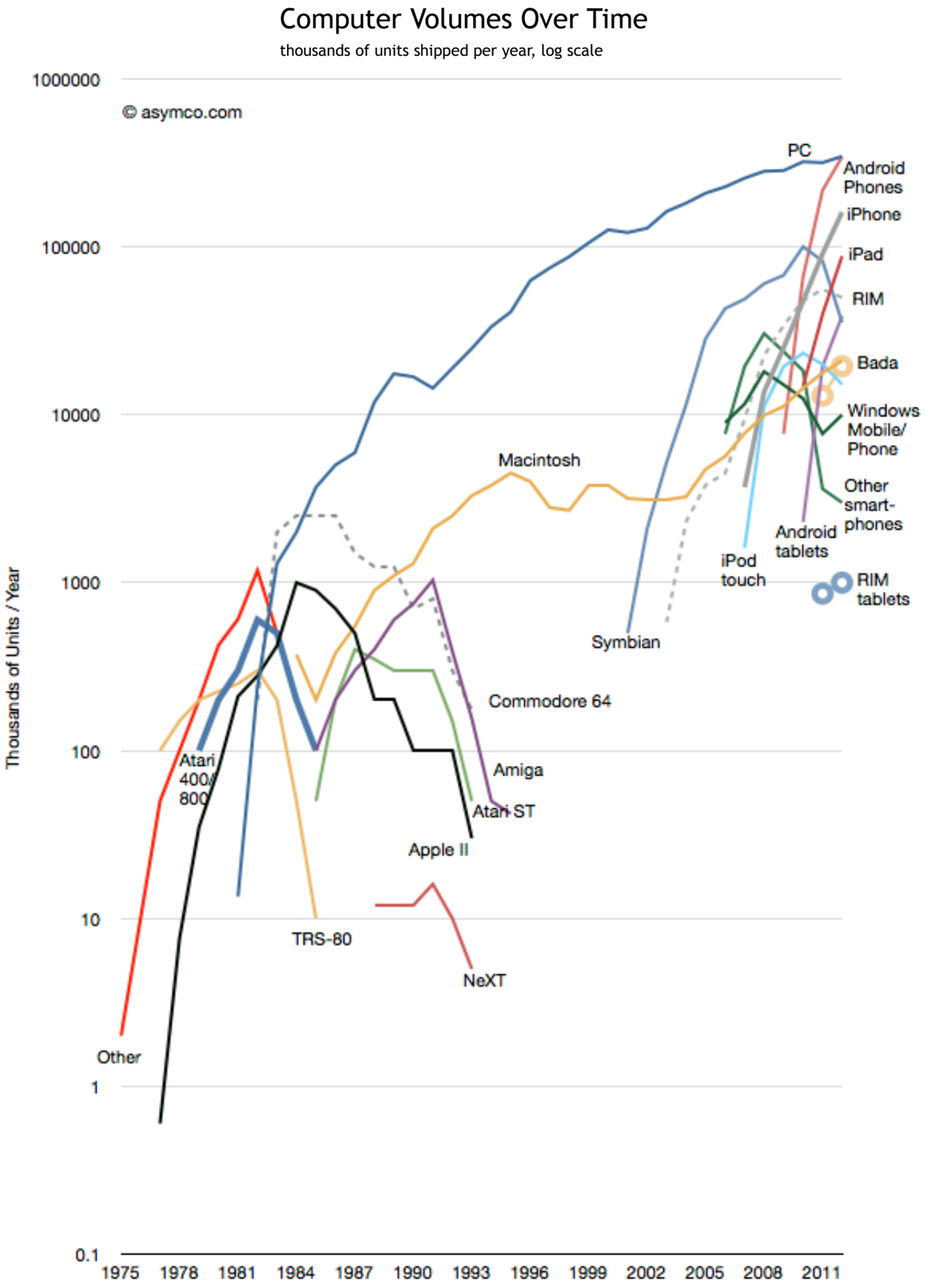
These new form factors add diversity to what was an already burgeoning market for mobile phones. In 2011, the U.S. passed the 100% mobile penetration mark – more subscribers than people – reaching a total of 327.6 million subscriptions.

Mobile + Cloud + Apps

The new mobile computers and new broadband wireless networks also revolutionized the software market.

More computer power and broadband connectivity – combined with a larger, more user-friendly interface – allowed Apple to develop and popularize the mobile software "app." The previous generation of consumers had known software chiefly as the Microsoft operating system Windows, office productivity applications like Office, and maybe boxed games or specialty programs. The World Wide Web introduced new kinds of software and content, often based on Java or Flash, but the Web was not a compelling experience on mobile devices.

The iPhone brought both an attractive Web experience and a wide variety of useful software to mobile devices for the first time. The ability to acquire new apps quickly from the cloud, first via Wi-Fi and then over 3G networks, probably changed the relationship between consumers and software forever.


Computer Volumes Over Time
thousands of units shipped per year, log scale
© asymco.com
Thousands of Units / Year
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NeXT
Other

Apple launched its App Store in mid-2008, and in just four years the number of available apps has grown to nearly 700,000. Users of Apple's mobile iOS have downloaded 30 billion apps. Apple says it has paid app developers $5 billion. On a related note, Apple says it has reached 400 million iTunes accounts (with consumer credit cards attached).

Google, meanwhile, launched its Android mobile OS and its own app marketplace after Apple, but both are growing even faster.

Google estimates 900,000 Android activations per day, for a total of 400 million Android devices. Choosing among more than 600,000 available apps, Android users have now downloaded more than 20 billion apps.

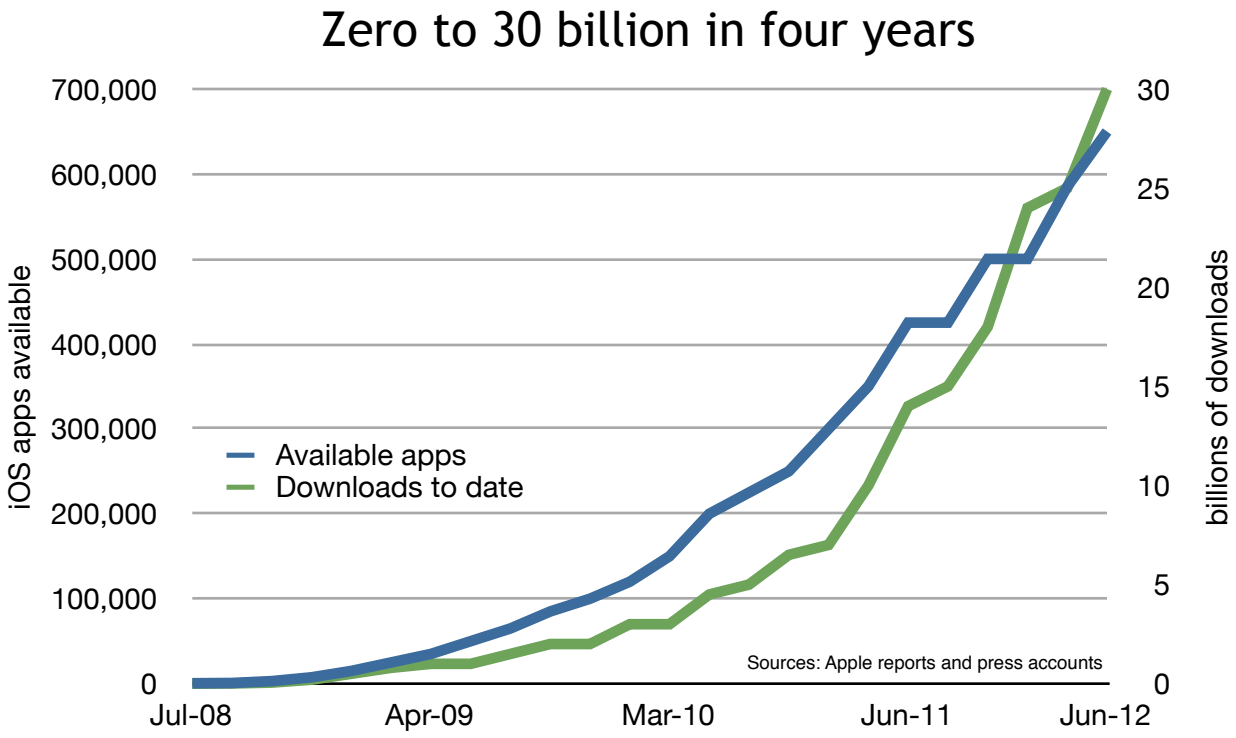
The reliance of mobile devices on the cloud will only grow. Increasingly, phones, tablets, and a host of thin clients, sensors, and other wireless nodes (Google glasses?) will depend on resources in the cloud – computing, storage, content, services, and real-time updates from apps that push (and pull) information to (and from) the network.

Features like Apple's Siri voice command-and-search will require always-on real-time access to cloud networks that can find and deliver accurate results without delay. Other device-based apps (or new HTML5 Web apps) will be closely integrated with computing, storage, and databases in the cloud – think real-time updates from social networks, sports events, or financial markets.

Video of all types will be the largest bulk traffic driver – entertainment, news, sports, video clip sharing, etc. Netflix, for example, is now streaming more than a billion hours of video per month.

Real-time communications – especially video chat – will of course impose growing burdens on a network originally conceived for the much less bandwidth-intensive needs of voice transmission.

So a combination of powerful factors is driving rapid mobile traffic growth. Mobile devices are the chief new personal computing paradigm. The volumes of these devices are reaching into the many billions worldwide. An



explosion of software, available instantaneously and in small chunks, being developed by thousands of creative coders, is driving new consumer demand and use. Consumers themselves are creating content with, for example, cameras and social networks. And broadband networks are enabling rich multimedia and video content in diverse incarnations.

In its latest network traffic report, Cisco projects North American mobile data will grow at a compound annual rate of 75% through 2016, when mobile traffic could reach nearly two exabytes per month.

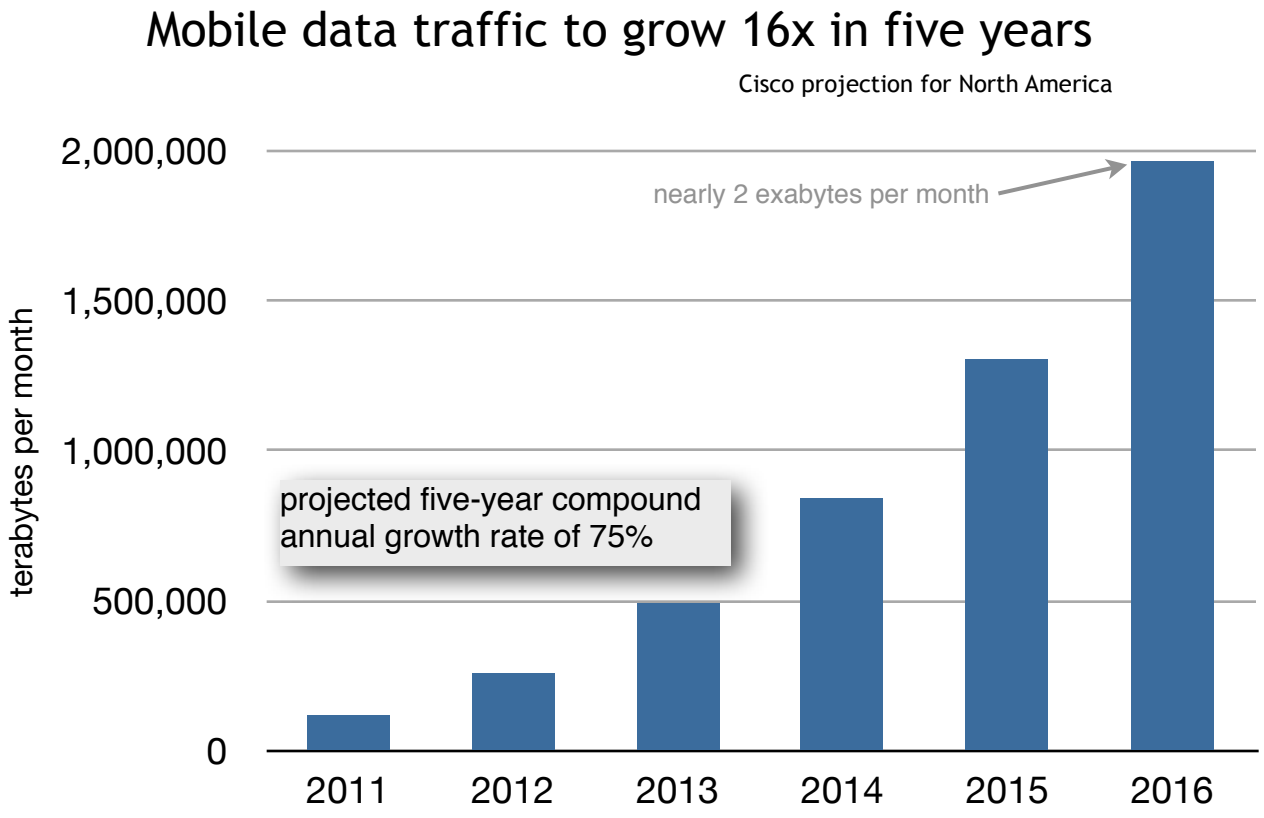
Competition

Opponents of open spectrum auctions and flexible secondary markets often ignore falling prices, expanding choices, and new features available to consumers. Instead they sometimes seek to limit new spectrum availability, or micromanage its allocation or deployment characteristics, charging that a few companies are set to dominate the market. Although the FCC found that 77% of the U.S. population has access to three or more 3G wireless providers, charges of a coming "duopoly" are now common.

This view, however, relies on the old analysis of static utility or commodity markets and ignores the new realities of broadband communications. The new landscape is one of overlapping competitors with overlapping products and services, multi-sided markets, network effects, rapid innovation, falling prices, and unpredictability.

It is, for example, worth emphasizing: *Google and Apple were not in this business just a few short years ago.*

Yet by the fourth quarter of 2011 Apple could boast an amazing 75% of the handset market's profits. Apple's iPhone business, it was widely noted after Apple's historic 2011, is larger than all of Microsoft. In fact, Apple's



non-iPhone products are also larger than Microsoft.

Android, the mobile operating system of Google, has been growing even faster than Apple's iOS. In December 2011, Google was activating 700,000 Android devices a day, and now, in the summer of 2012, it estimates 900,000 activations per day. From a nearly zero share at the beginning of 2009, Android today boasts roughly a 55% share of the global smartphone OS market.

In 2009, Gartner projected market shares for mobile operating systems in 2012. Below are the projected shares for full-year 2012 and the rough actual shares for the first quarter of 2012:

Mobile OS	Projection 2012	Actual 1Q 2012
Symbian	39%	8%
Android	14.5%	55%
iPhone	13.7%	23%
Windows	12.8%	3%
Blackberry	12.5%	7%
Linux	5.4%	4%
WebOS	2.1%	–

The projections missed the mark of actual shares by wide margins. This testifies less to Gartner's forecasting abilities than to the dynamism of the mobile marketplace. We doubt anyone could have accurately forecast this outcome, nor that projections of these markets going forward will be much better.

Apple's iPhone changed the structure of the industry in several ways, not least the relationships between mobile service providers and handset makers. Mobile operators used to tell handset makers what to make, how to make it, and what software and firmware could be loaded on it. They would then slap their own brand label on someone else's phone.

Apple's quick rise to mobile dominance has been matched by Blackberry maker Research In Motion's fall. RIM dominated the 2000s with its email software, its qwerty keyboard, and its popularity with enterprise IT departments. But it couldn't match Apple's or Android's general purpose computing platforms, with user-friendly operating systems, large, bright touch-screens, and creative and diverse app communities.

Sprinkled among these developments were the rise, fall, and resurgence of Motorola, and then its sale to Google; the rise and fall of Palm; the rise of HTC; and the decline of once dominant Nokia.

Apple, Google, Amazon, Microsoft, and others are building cloud ecosystems, sometimes complemented with consumer devices, often tied to Web apps and services, multimedia content, and retail stores. Many of these products and services compete with each other, but they also compete with broadband service providers. Some of these business models rely primarily on hardware, some software, some subscriptions, some advertising. Each of the companies listed above – a computer company, a search company, an ecommerce company, and a software company – are now major *Internet infrastructure* companies.

As Jeffrey Eisenach concluded in a pathbreaking analysis of the digital ecosystem ("Theories of Broadband Competition"), there may be market concentration in one (or more) layer(s) of the industry (broadly considered), yet prices are falling, access is expanding, products are proliferating, and innovation is as rapid as in any market we know.

The Spectrum Question

Large capital investments in wireless and backhaul networks have driven American

mobile innovation and, for the most part, accommodated traffic demand. U.S. service providers invested $26 billion in wireless infrastructure in 2010 and another $26 billion in 2011. For the period 2001-11, U.S. wireless investment was around $258 billion.

Spectrum, however, is becoming a limiting factor. More cell towers (with antennas, base station equipment, and backhaul links) are sometimes but not always the best way to boost capacity. They are expensive and often difficult to "site" given local politics and appropriate geographic availability. The new technologies, such as 4G, are also better suited to wider spectrum bands, which aren't always available in the older allocations.

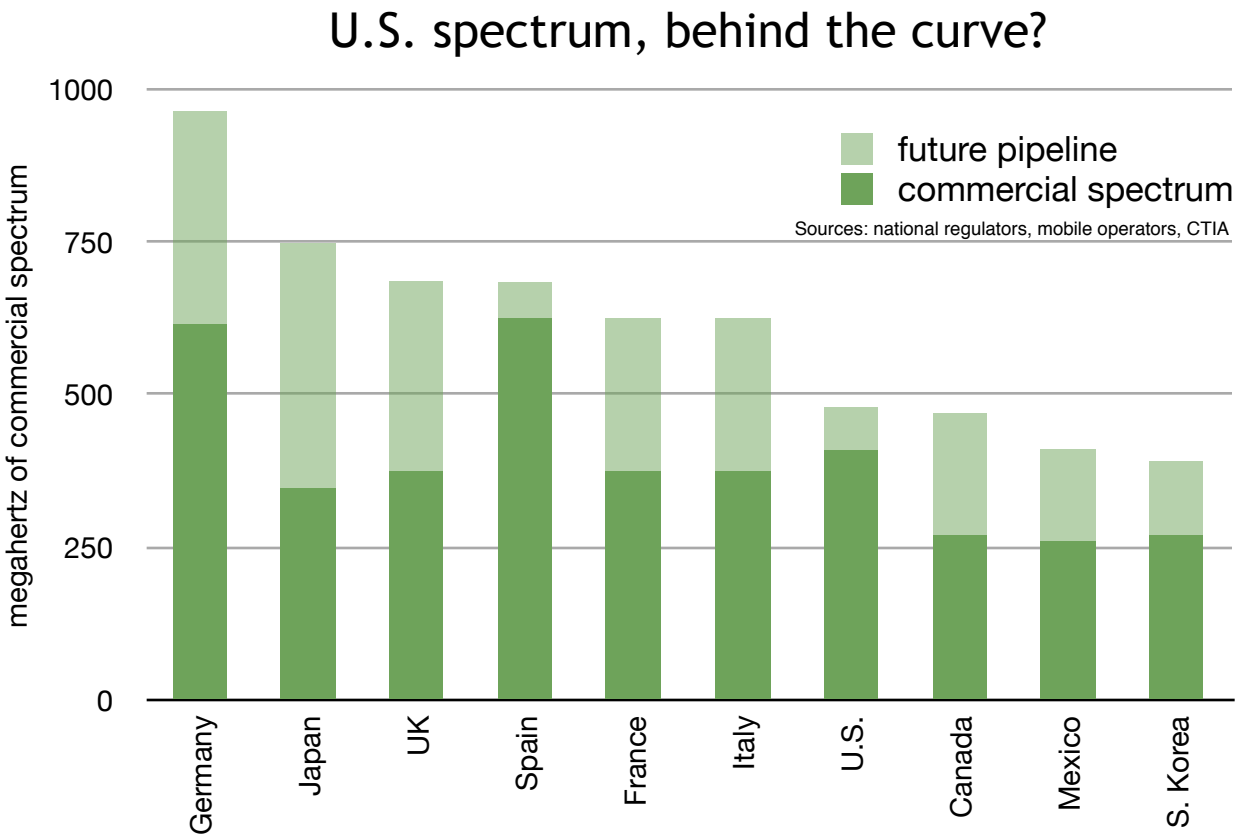
Most mobile operators in the U.S. today control between 50 and 90 MHz of spectrum. Wireless engineering consultant Peter Rysavy estimates that by 2016 they might need more than 200 MHz to serve the busiest markets.

The U.S. appropriately established a goal to unleash 500 MHz of spectrum by the end of the decade and 300 MHz by mid-decade. But its actual spectrum policies are falling far behind this objective.

As the chart below shows, the U.S. lags many other advanced economies in the total amount of spectrum likely to be available in the next several years.

On only four occasions has the U.S. opened large new spectrum bands for mobile use – cellular in the 1980s, PCS in the 1990s, and AWS and 700 MHz in the mid- and late-2000s, respectively. Moreover, it often takes five to 10 years between the decision to release new spectrum and its eventual arrival in the marketplace (via auctions and other means).

For these reasons and more, secondary markets for spectrum are crucial. They provide a modest amount of flexibility and "liquidity" to a sometimes inflexible market. (For



example, AT&T and Sirius XM last month proposed a swap of WCS spectrum that would allow AT&T to more quickly deploy 4G capacity; and Verizon and T-Mobile proposed a swap of AWS spectrum that would enlarge T-Mobile's net spectrum position but give Verizon a better contiguous allocation.)

Unleashing spectrum through auctions and allowing greater flexibility to use, buy, and sell existing private spectrum is important to accommodate existing demand for new data services and to drive future wireless innovation. Spectrum policy and politics, however, has been deteriorating.

- The FCC and Justice Department vetoed AT&T's merger with T-Mobile, which, through an expansion of cell sites and addition of spectrum, would have improved AT&T's 3G network now and accelerated AT&T's 4G roll-out by several years.

- The FCC battled with Congress over a spectrum auction bill that could unleash hundreds of megahertz of unused and underused spectrum. The FCC wanted broad authority to restrict and massage the auctions in various ways and to manage the technical and business models of the wireless arena. The House wanted open auctions that would not predetermine who can bid, how much companies can buy, and how buyers use the spectrum. The proposal finally became law early this year, but arguments persist over how the FCC will conduct the auctions. Even in the best of circumstances, the process will take years.

- LightSquared, a venture of Harbinger Capital, sought approval of its nationwide 4G wholesale network but ran into a wall of technical opposition from the GPS community, which claimed LightSquared interfered with GPS signals, situated in spectrum next door. LightSquared lost its bid, and so for now its 50 MHz of spectrum is dark.

- The government is now reviewing Verizon's announced purchase of SpectrumCo., the large spectrum holdings of several U.S. cable TV companies. Several times the government delayed its decision and asked for more information from the parties, leading many observers to doubt the transaction would be approved. More recently, it became known the FCC was likely to approve the transaction. But now the Department of Justice is reviewing a distinct but related proposal in which Verizon and the cable companies would engage in some joint-marketing of products. DoJ's hesitation to approve the marketing agreement is now delaying the spectrum transaction.

These events threaten to slow the innovation and hypergrowth the mobile industry has recently enjoyed.

Not only do these actions keep spectrum from being used most efficiently or off the market entirely, but they impose further opportunity costs on the ecosystem. For example, SpectrumCo.'s spectrum remains offline because the cable companies decided not to go ahead with their own mobile network build. But if SpectrumCo. cannot sell its spectrum, it's not just the spectrum that goes unused. SpectrumCo.'s owners, the cable companies, are also deprived of several billion dollars in capital they might use to enhance their wireline broadband networks.

Building and Operating Networks

There are essentially three ways to increase wireless capacity – more spectrum, more cells, and faster technology. We need all three.

We can multiply the same bands, or "reuse" spectrum, with a larger number of smaller cells transmitting signals a shorter distance. Deploying more small cells will be a major part of the wireless expansion for many years to come. Yet more cells mean more expense – and more complexity.

We can push more bits through a given band of spectrum – better spectral efficiency. This,

too, is important. It is true, with LTE, we are closing in on Shannon's theoretical limit of how many bits can be transmitted over a channel per unit time. It is also true that we keep finding ingenious new ways to create more channels – e.g., MIMO antenna technologies.

Nevertheless, without the third leg of the wireless stool – spectrum – the mobile equation collapses. We mix and match these three resources, based on cost and network architecture, to produce the most capacity at the lowest cost. Take away spectrum, and we can do a lot to compensate – more cells, more investment, more technology, and, yes, more cost and more complexity. And thus higher prices and other problems.

One crucial consideration is that as we deploy new network technologies and nodes, we must continue operating existing networks serving older generations of devices. As Rysavy notes, mobile operators until the year 2020 "will have to allocate separate spectrum for 2G, 3G, and 4G, a strain on their spectrum holdings beyond the pressure from escalating mobile broadband demand."

The simpler solution if we want to encourage continued innovation at its fastest possible clip is to allow ecosystem companies to build networks and deliver services using the best mix of resources. This means not artificially limiting the use of spectrum but allowing it to flow to its highest value uses.

If and when the incentive auctions championed by FCC Chairman Genachowski are successfully completed, it will be a major achievement that will help fuel another round of mobile innovation. It should also be noted that in recent days FCC Commissioners Rosenworcel and Pai have urged greater speed in regulatory decisions and a more concrete timeline for the spectrum auctions.

Unless and until the FCC's 500 MHz wireless big bang becomes a reality, however, an active, flexible secondary market for spectrum will have to fill the gap. EE

Soft Power: Zero to 60 Billion in Four Years

> *Apps, the new American software industry*
> *Broadband platform fuels software creativity*
> *Mobile + Cloud = Endless Apps*
> *Macroeconomic effects: the Soft Power jobs machine*

BRET SWANSON > December 5, 2012

Mobile apps. Has the world known a faster, broader, deeper diffusion of a major technology? Doubtful.

Apple launched the iPhone in 2007 and the App Store a year later in summer 2008. Google followed with Android apps the following year, in 2009. In this short timespan, apps have revolutionized the way we use our mobile devices and the Internet – and the way we think about software.

In 2011, worldwide smartphone sales reached 488 million units, topping PC sales for the first time. Smartphone sales in 2012 could tip 700 million.

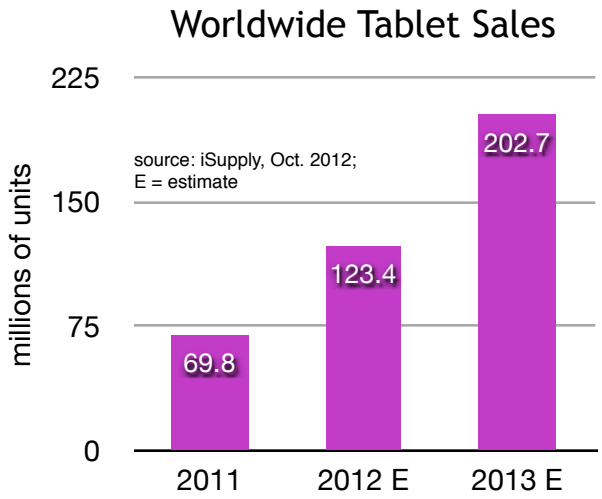
Tablet sales of 70 million in 2011 may, according to iSupply, grow to around 123 million in 2012 and could top 200 million in 2013. This means by next year sales of smart mobile devices could top one billion units.

Computer hardware and software have been paired, at least conceptually, since 1843 when Ada Lovelace, daughter of Lord Byron, wrote a "program" to calculate Bernoulli numbers on Charles Babbage's never-completed Analytical Engine. A hundred years later, IBM was feeding punchcards through its business machines. Then came programmable mainframes, the silicon microprocessor, the PC, and the Web server. Over the last half century, software has grown to be a larger market than computers. But now, with the added ingredient of *broadband communication*, software has entered a new era.

Smart mobile devices are the most personal of computers. The colossal numbers of these devices, and their connectivity to each other and to all the Internet's vast resources, creates a market so large and so diverse that the economic forces of innovation and specialization are supercharged. This platform of distributed computation and bandwidth offers unlimited possibilities to create tools and content serving every interest. We call this phenomenon Soft Power.

Rx for Innovation

In October, the *New York Times* profiled a young internal medicine resident, Dr. Alvin Rajkomar, showing the ways mobile apps are changing just one occupation.



"Among the new crop of device-happy physicians," wrote the *Times*, "Dr. Rajkomar is now an elder statesman of sorts, showing trainees his favorite apps, along with shortcuts through the electronic medical record and computerized prescribing system.

"He stores every clinical nugget he finds on an application called Evernote, an electronic filing cabinet. 'I use Evernote as a second brain,' he said. 'I now have a small textbook of personalized, auto-indexed clinical pearls that I carry with me at all times on my iPhone.'

"Along with MedCalc, the clinical calculator, Dr. Rajkomar's phone has ePocrates, an app for looking up drug dosages and interactions; and Qx Calculate, which he uses to create risk profiles for his patients. His favorite technology is his electronic stethoscope, which amplifies heart sounds while canceling out ambient noise."

Similar stories are playing out across every workplace and in daily life. Software and apps, even those for medicine, are not new. But the Soft Power revolution is. The number and diversity of software tools towers over anything known before.

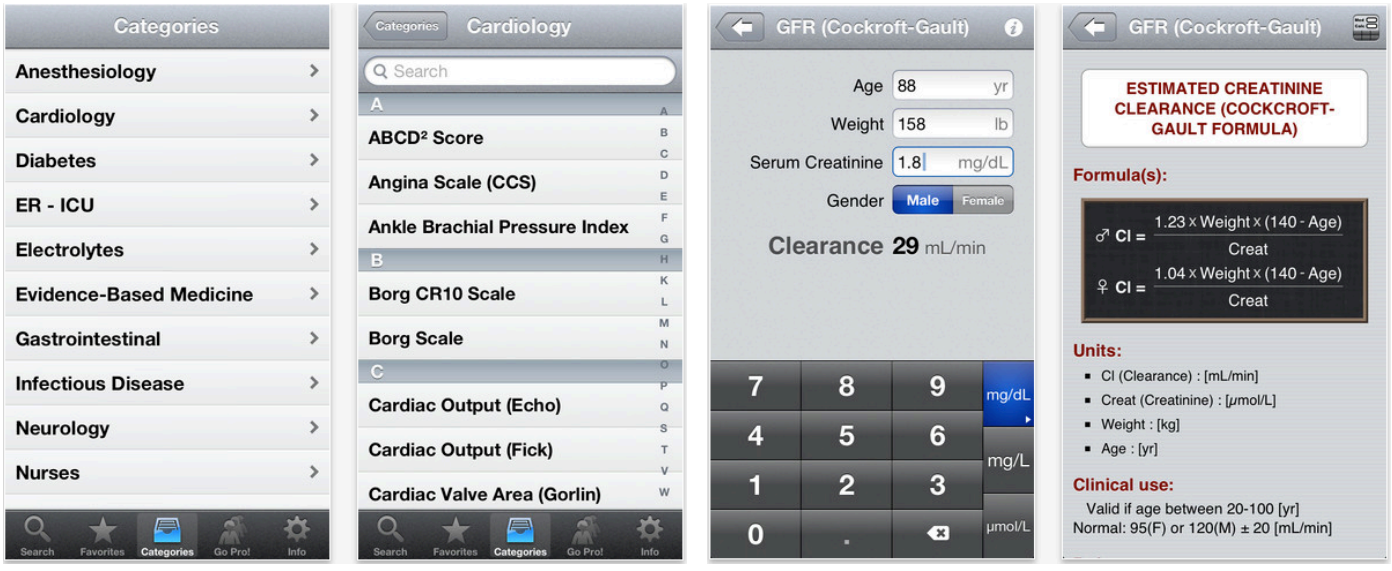
In the era of mainframe business computers, large companies mostly developed internal custom software for their own one-of-a-kind needs. In the minicomputer years, companies like DEC and Wang bundled software with the systems they sold to a growing population of small and medium-sized businesses. Bell Labs and other research institutes and university scientists built operating systems like Unix.

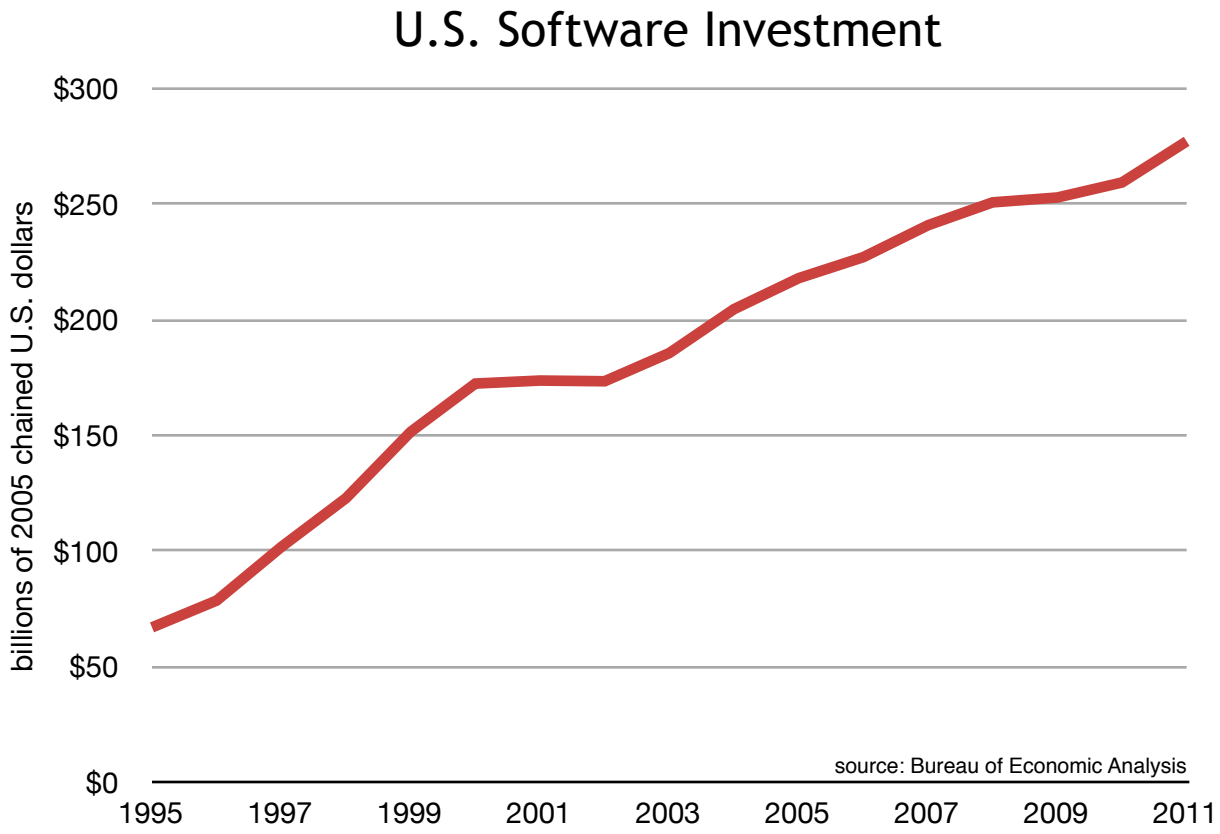
The PC era, with its dominant duo of Intel and Microsoft, democratized computing for the first time, offering machines individuals could buy and the basic tools of the time – word processing, spreadsheets, databases, simple graphic design and publication programs, and games.

Microsoft towered over the operating system and office application markets. The boxed software market was significant for Windows-based PCs. Apple, which designed its own hardware and software, however, had trouble attracting a large third-party base of software offerings.

Physicians' Assistants: medicine goes digital

pictured here: MedCalc




U.S. Software Investment
billions of 2005 chained U.S. dollars
$300
$250
$200
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$100
$50
$0
source: Bureau of Economic Analysis
1995
1997
1999
2001
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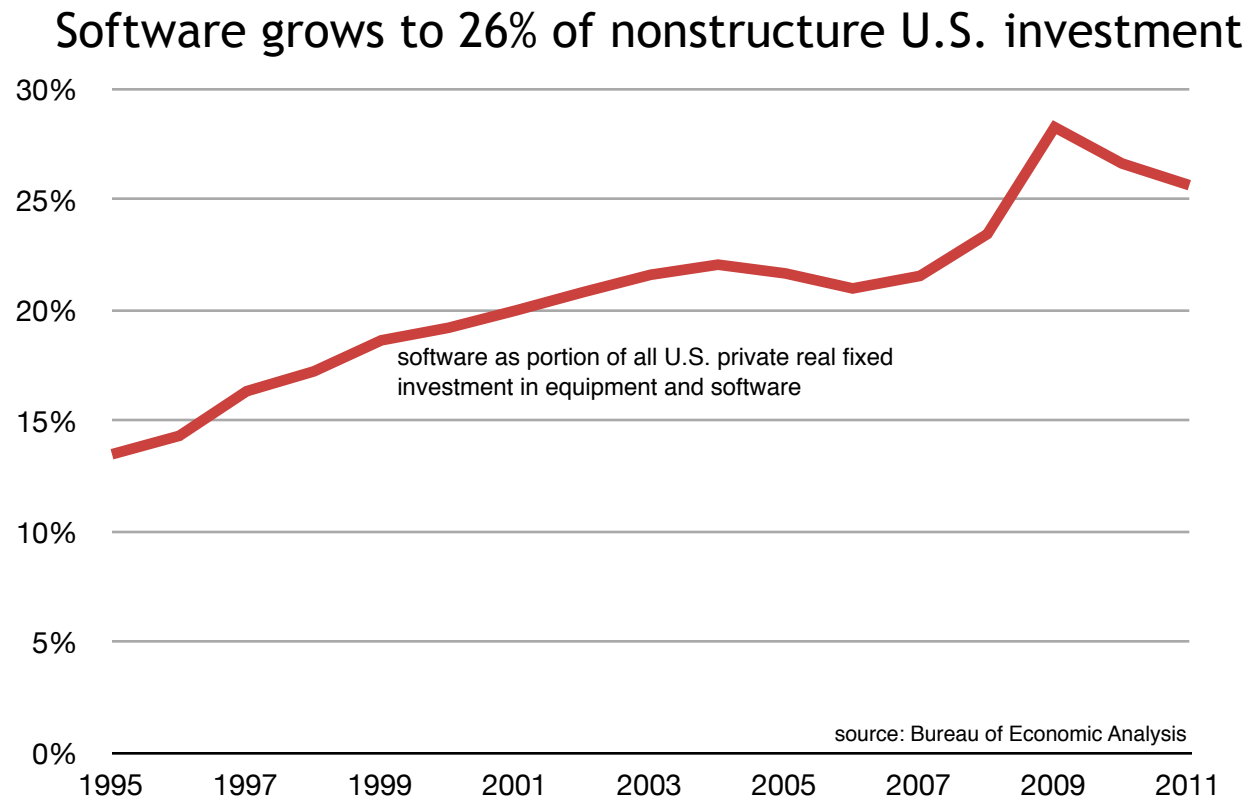

Software grows to 26% of nonstructure U.S. investment
30%
25%
20%
15%
10%
5%
0%
software as portion of all U.S. private real fixed investment in equipment and software
source: Bureau of Economic Analysis
1995
1997
1999
2001
2003
2005
2007
2009
2011

The moniker – "boxed" software – helps explain one crucial difference with the new Soft Power era. We were selling bits in boxes. For cereal, boxes are fine. For bits, not ideal.

Before apps, the U.S. software industry was already massive. But much of it was hidden – in back-office databases, for example, or on servers in remote data centers, or in industry-specific manufacturing systems. There was of course an explosion of enterprise software, such as Oracle and SAP databases and customer relationship management (CRM), often "implemented" by sprawling teams of consultants charging millions of dollars. Linux, launched in 1991, meanwhile, drove the open source movement and is today one of the most widely used operating systems (it is, for example, used across Google's network infrastructure and is the basis for Google's mobile operating system Android).

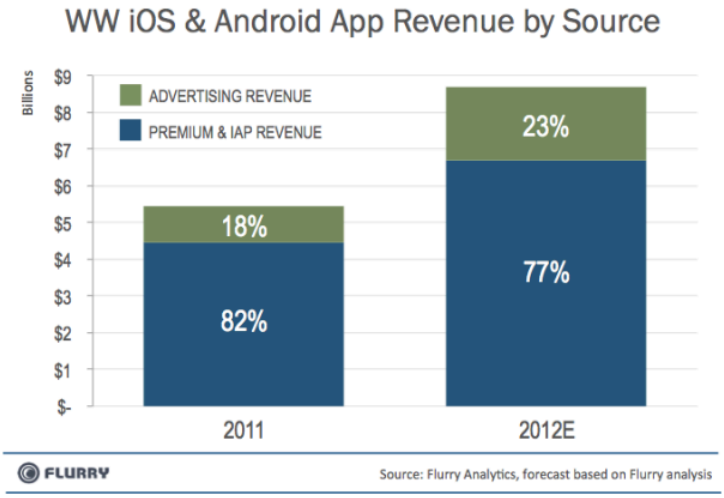
The Internet brought new kinds of software to the masses – though most probably didn't think of it as software. The Web offered a new model of content distribution. The user-friendly browser and HTML made the Web and the Internet's resources easily accessible to non-specialists. Java, with its promise of "write once, run anywhere," unleashed apps from OS and device in theory and, to a great extent, delivered in practice. (In a preview of apps, we called them "applets." Remember?)

By 2007, the U.S. invested around $240 billion a year in software. The mobile environment, however, remained unsatisfying. Despite attempts from many device makers, phones were still mostly phones, and mobile still had not tapped the power of the Net and Web.

App-celeration

Then came iPhone. Apple expanded the display, improved input-output with the touchscreen, and offered the first truly appealing mobile browser. At the same time, we were moving from 2G to faster 3G mobile data networks, and Wi-Fi was growing. There was, however, an even bigger conceptual breakthrough: the mobile device as general purpose computer, open to the world of software, powered by the resources of the cloud.

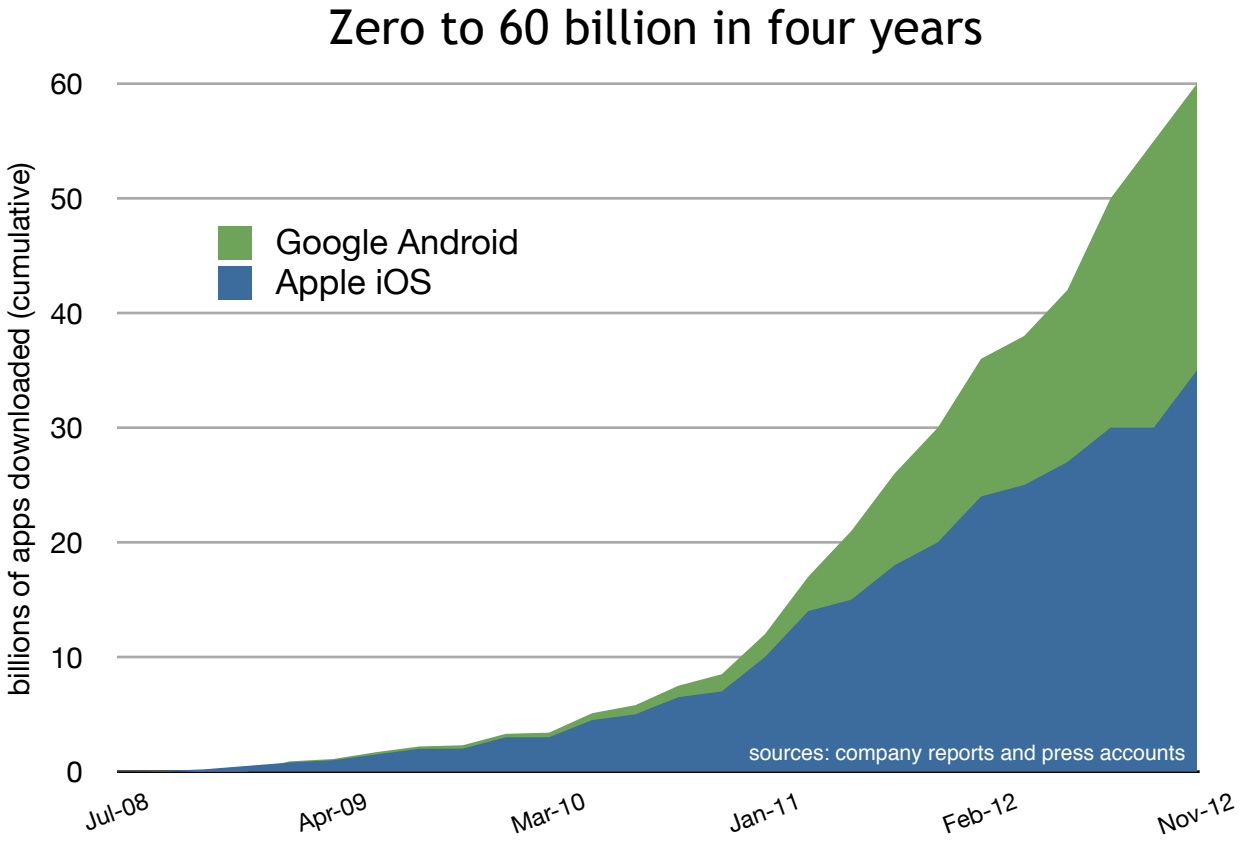
The result astounded probably even Steve Jobs. In just four years, since the opening of the Apple App Store in the summer of 2008, the number of available mobile apps has grown from essentially zero to 1.425 million.

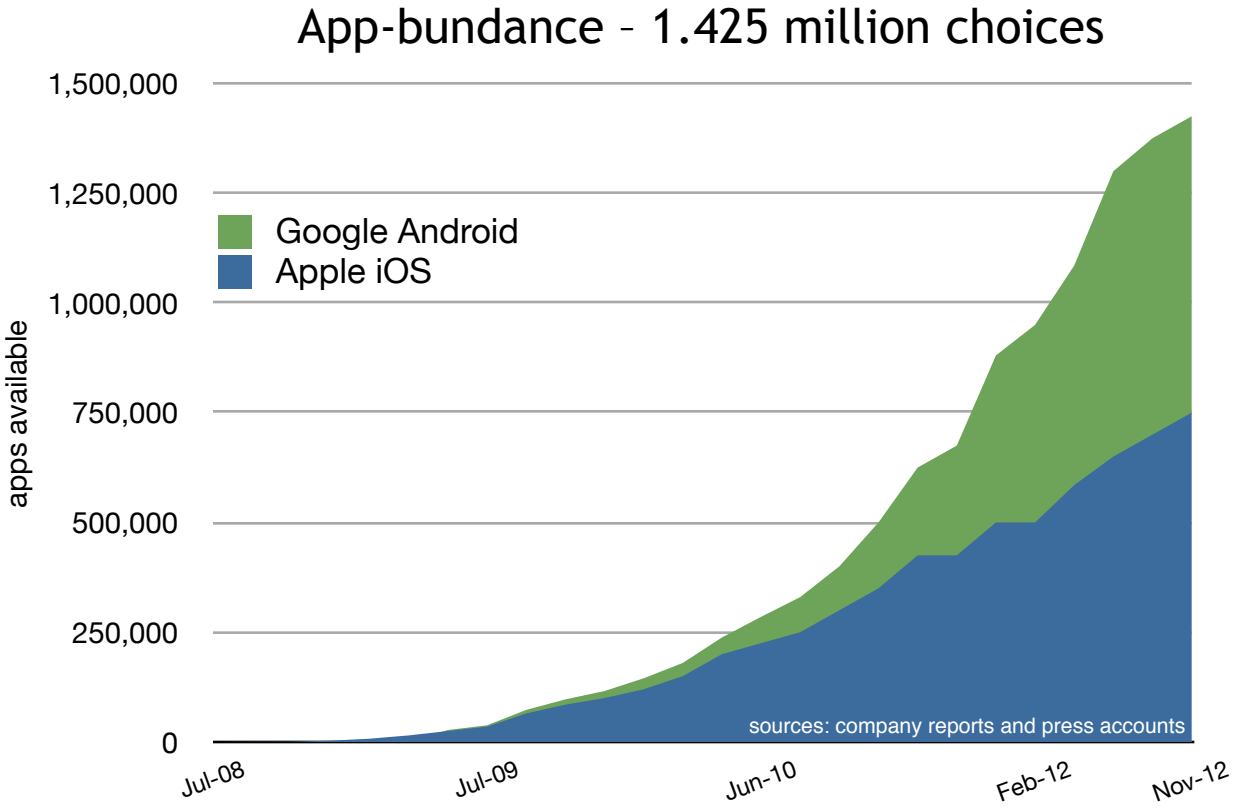


In an extraordinary explosion of innovation, mobile app downloads grew from (again) essentially zero to 60 billion. (See charts on page 5.)

Although the great majority of apps are free, apps are real business. Advertising, premium, and in-app revenue topped $5 billion in 2011 and could approach $9 billion in 2012. Apple says it has paid app developers $6.5 billion for their share of revenue flowing through the App Store.

Google's Android lagged Apple by over a year but quickly caught up. Most of the non-Apple device makers now produce smartphones and tablets based on Android. Samsung especially has emerged as iPhone and iPad's strongest device rival.


Zero to 60 billion in four years
billions of apps downloaded (cumulative)
60
50
40
30
20
10
0
Google Android
Apple iOS
sources: company reports and press accounts
Jul-08
Apr-09
Mar-10
Jan-11
Feb-12
Nov-12


App-bundance – 1.425 million choices
apps available
1,500,000
1,250,000
1,000,000
750,000
500,000
250,000
0
Google Android
Apple iOS
sources: company reports and press accounts
Jul-08
Jul-09
Jun-10
Feb-12
Nov-12

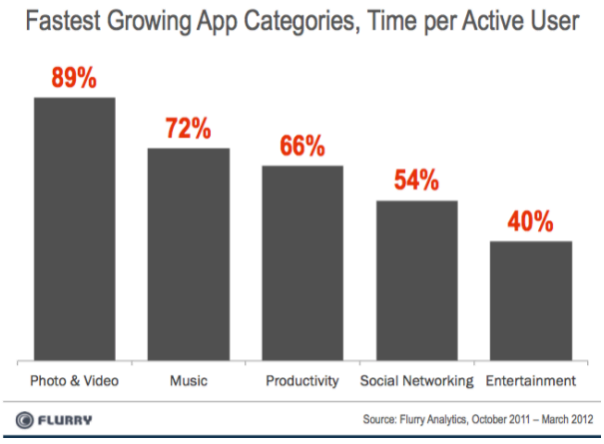
In just three and a half years, Google Play (the Android marketplace) has accumulated 675,000 apps that have been downloaded, in aggregate, 25 billion times. This compares to Apple iOS figures of 750,000 available apps and 35 billion downloads. (See chart on page 8.)

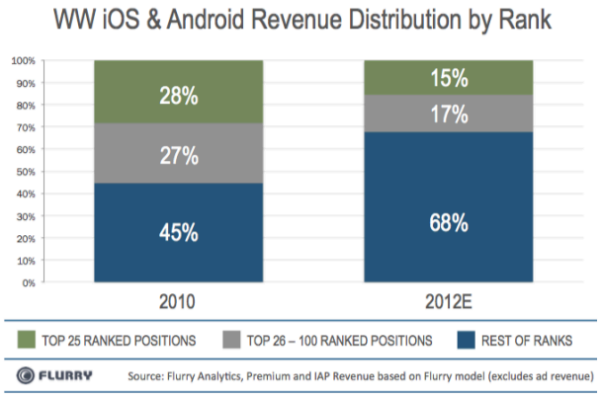
Mobile + Cloud = Endless Apps

To understand the ascent of mobile, think about this: Qualcomm, the wireless chip maker, just surpassed the market value of Intel, the titanic microchip company of the computer era. Communications has trumped computation.

The size of the mobile market and the power of broadband connectivity have combined to reshape both the computer and software industries. PC and laptop sales are stagnant or falling, while mobile form factors are surging. We often now care more about what cloud infrastructure and software we use, rather than what's under our desk. Large companies and home-office entrepreneurs are able to conceive, build, and rapidly distribute apps to suit every existing need and newly imagined niche.

Compared to software of the past, mobile apps are inexpensive to develop and distribute. They are smaller. They are easily updatable. They are interactive. And because most of them are inexpensive to end-users (in terms of money, time, and computer resources), volumes are large, and trial and error feedback is robust. In the PC world, a software package had to be large enough – it had to do enough things – to be worth the developer's wile and the consumer's money. It made little sense to build a tiny, stand-alone app for which any market was small and uncertain. And any small apps that did get built were quickly gobbled up into the Windows OS. Compared to boxed software that was expensive, bloated, limited in choice, and had to last years, apps are throw-away items – instantly obtainable . . . and discardable. Mobile devices, moreover, are always with us and always connected, extending the time we each spend with our *most personal* computer. This vastly expands the arena of potential consumers – and thus, in a virtuous circle, the arena of producers. Diversity and quality grows.





Some apps are merely optimized versions of webpages, offering a better experience on a small device than a mobile Web browser can deliver. But many apps would never have been conceived as websites. A substantial number of apps make special use of the new mobile computers' integrated cameras and GPS capabilities for location-based services.

The history of digital technologies is radical integration, and mobile is no different. Amazon finally succeeded in creating a flourishing market for ebooks with its Kindle device. The Kindle, however, was quickly "appified" and its functionality integrated into any smart device. Millions of Garmin GPS mapping de-

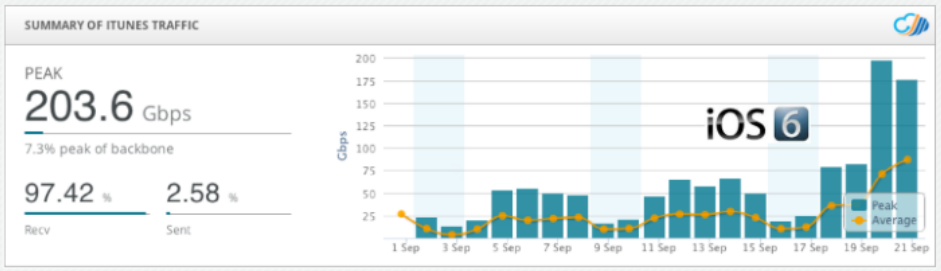
vices similarly have likewise been swallowed up by apps. The same thing happened to GameBoys and other portable game machines. The most extreme hardware integration may be the camera. The stand-alone digital camera only achieved widespread adoption circa the year 2000, yet less than a decade later this radically new device was already being enveloped by the mobile handset. The technology and wealth that yielded this hyper-integration and wiped out the old camera market then created a large new market for high-end DSLR cameras.

Digital technologies have a way of cycling and turning back on themselves. Several years ago, we thought of putting a few apps onto a phone. Now "phone" is just one of endless apps on a mobile computer.

Some apps are products. Some apps link customers to services. Some are "freemium" offerings. Others are based on advertising. Still more are just part of integrated communications strategies or tools built for specific events.

The browser/Web combination offered many of the same advantages over the previous PC/OS/program paradigm. Yet the mobile world needed a more optimized solution. As Clayton Christensen often told us, in an arena of undershoot, where performance isn't yet good enough, it often takes an integrated, optimized solution to perfect the interfaces and produce a smoothly functioning product. This was the mobile device before the iPhone. It took Apple to integrate its sleek, touchscreen hardware, iOS software, and well-conceived App Store, to make the sys-

Right: *iTunes traffic surged to 7-12% of all N. American backbone traffic upon release of iOS 6 this autumn. (source: DeepField Networks)*



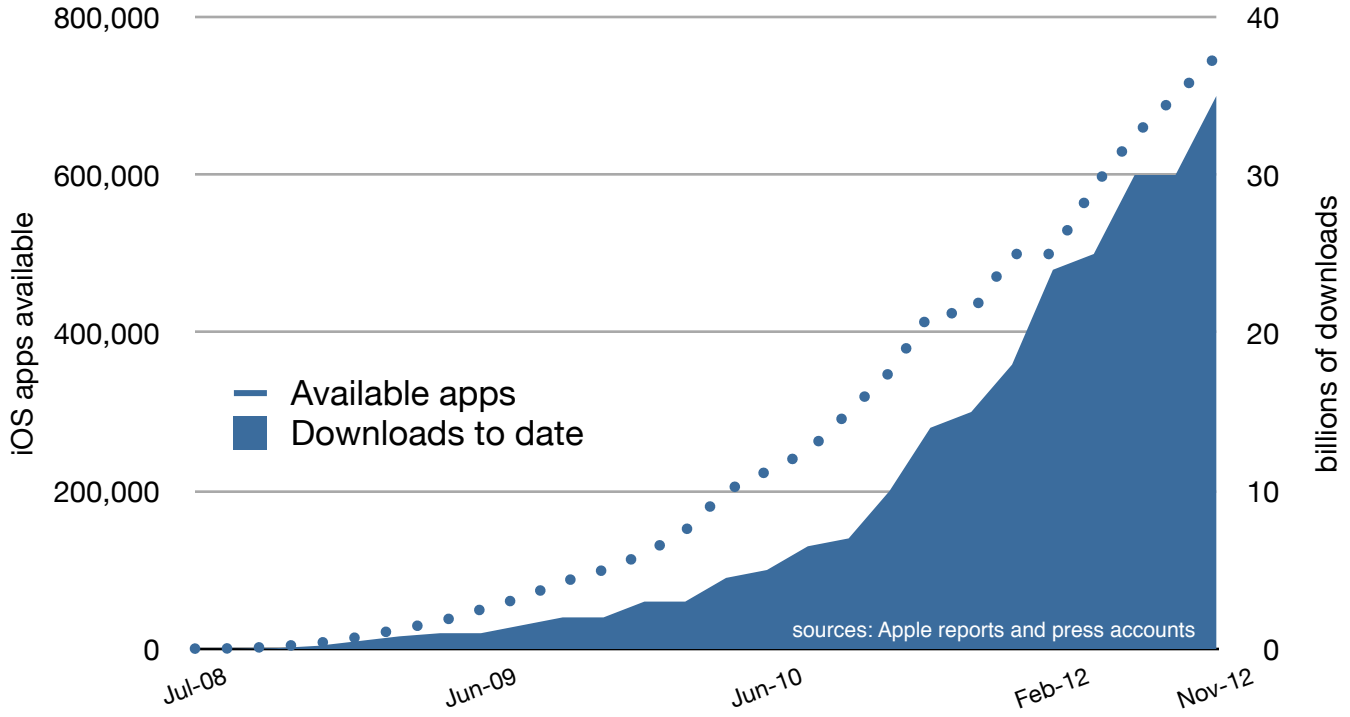
Graph of daily traffic peaks for iTunes across several North America providers this month. iTunes traffic surges to 7-12% of North American backbone traffic immediately after the release of IOS6. All data comes from anonymized benchmark data shared by participating providers.

Below: *Google Play and iTunes app downloads account for the 7th and 9th largest share of wireless data traffic, respectively. (source: Sandvine)*

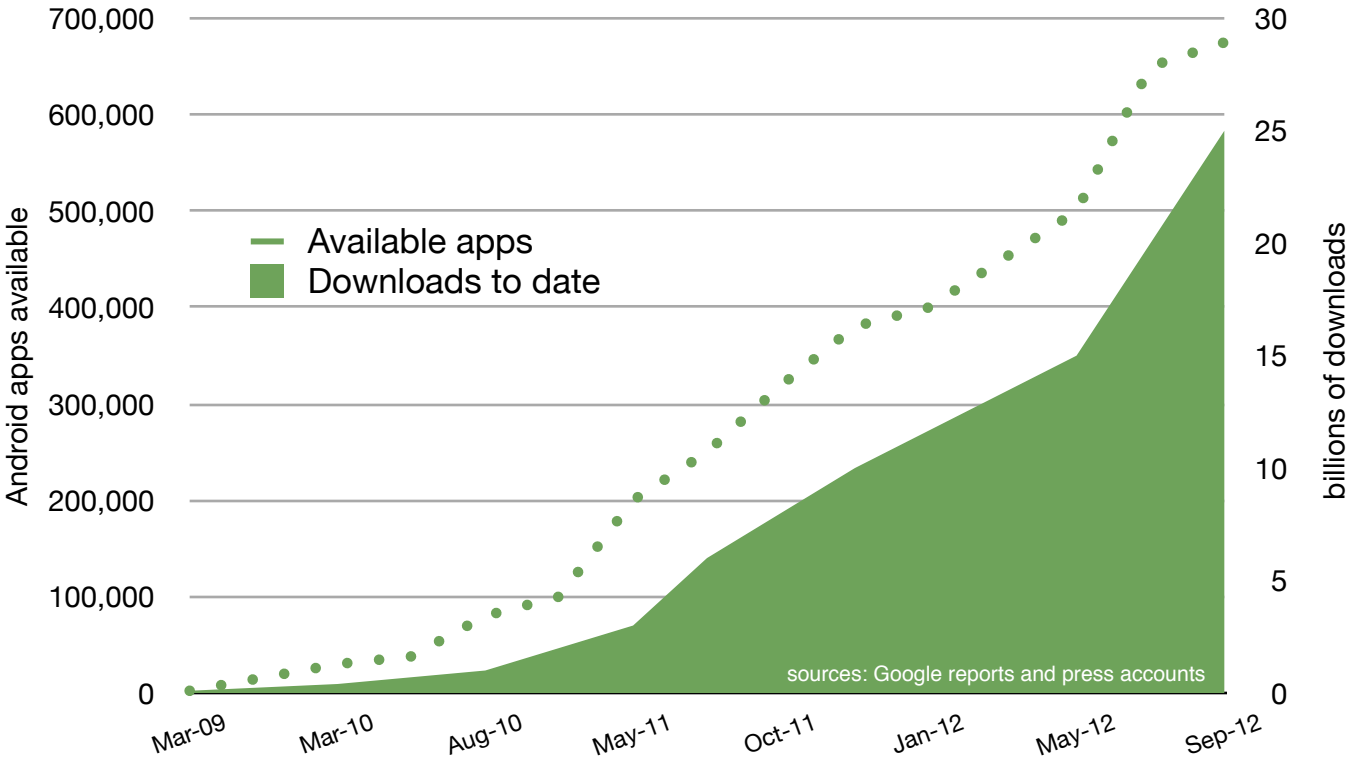
	Upstream		Downstream		Aggregate	
Rank	Application	Share	Application	Share	Application	Share
1	Facebook	15.43%	YouTube	30.97%	YouTube	28.03%
2	HTTP	13.60%	HTTP	14.37%	HTTP	14.28%
3	SSL	13.26%	SSL	8.92%	SSL	9.49%
4	YouTube	7.91%	MPEG	8.90%	Facebook	7.95%
5	Google Talk	2.23%	Facebook	6.83%	MPEG	7.93%
6	MPEG	1.92%	Pandora Radio	5.15%	Pandora Radio	4.74%
7	Pandora Radio	1.90%	Google Play	3.27%	Google Play	2.96%
8	Skype	1.56%	Netflix	2.69%	Netflix	2.42%
9	SMTP	1.52%	iTunes	1.46%	iTunes	1.34%
10	Yahoo! Mail	1.49%	Flash Video	1.18%	Flash Video	1.05%
	Top 10	60.82%	Top 10	83.74%	Top 10	80.19%

sandvine

Apple iOS growing fast



Google Android growing faster



tem work well. Apple even partnered with AT&T to make sure the network supported new smartphone functionality. Then we were off to the races.

Although Android has achieved dramatic overall success, the more modular pairing of Android with various handset manufacturers still exhibits some of the typical problems of unoptimized solutions.

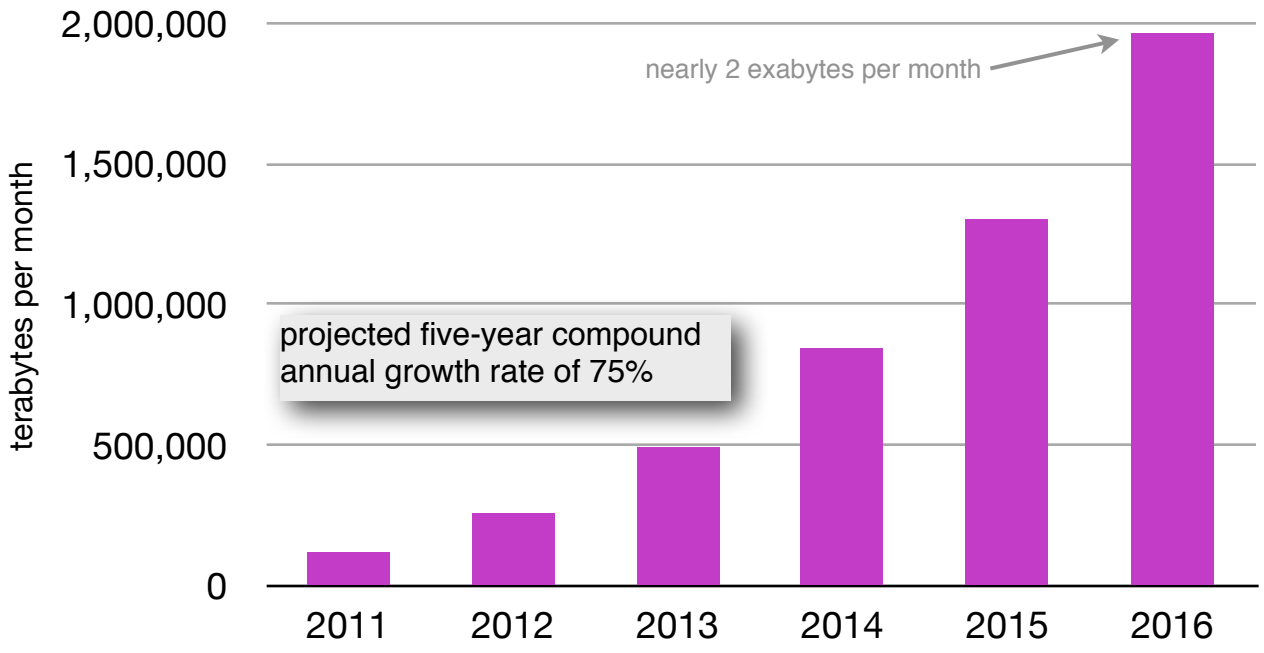
As devices, networks, and Web resources improve, some portions of the ecosystem will become more modular. It is possible that HTML5, the next generation of the basic Web language, will prove highly effective at mimicking the optimized functionality of apps while retaining the platform neutrality of the Web, among other Web virtues. Technology always cycles between integration/optimization and modularization/standards. The point is not that native apps, per se, will always be superior. But the fact is that optimized apps were required to show the true power of mobile. As the open Web replaces some (or many) low-end apps, we will likely conceive other, more advanced tools that will have to be built, at least initially, as native apps.

Whatever the case, both native apps and Web apps will be powered by increasingly sophisticated and pervasive cloud resources: storage, computation, collaboration, transactions, location services, content distribution, and remote 3D video rendering.

Big Data companies will collect and parse vast location, preference, and identity information. “Post-Big Data” ventures, like Jeff Hawkins’ Numenta, aims to analyze not stale databases, as he might put it, but real-time bitstreams flowing in from all the world’s data tributaries. A new, largely invisible infrastructure is being built to power apps from afar. At his new company, Talko, Ray Ozzie, the Lotus Notes founder and former Microsoft executive, is reportedly building a host of cloud-based support services so app developers can lean forward and focus on their own products and customers while plugging into to an existing back-end platform.

Mobile data traffic to grow 16x in five years

Cisco projection for North America



This dependence on the cloud will require ever increasing network coverage and speed. This means more cell towers, more small cells, more Wi-Fi, more advanced technology like LTE and MIMO, more spectrum, and of course more investment.

In its semiannual state-of-the-industry report, CTIA showed that as of June 2012 U.S. mobile subscribers totaled 321.7 million (more than 100% penetration), and smartphone users jumped 37% to 130.8 million. Mobile data traffic for the year preceding June 2012 was 1.16 trillion megabytes (or over one exabyte), a 104% increase over 2011. For fall 2012, Sandvine, using its own distinct measurement tools and network samples, reported mean mobile data consumption in North America of 317.2 megabytes per month. This yields an annual rate of around 1.22 exabytes. AT&T says in the last five years its mobile data traffic has grown 25,000%.

One hundred percent increases produce very large numbers very fast. And the mobile network companies have been investing vast sums to both drive new innovation and keep up with this data exaflood.

Macrosoft

The App Economy is not only a story of new tools and consumer benefits, it is also about entrepreneurship and jobs. People conceived and wrote the code for those 1.425 million available apps. They developed business models around them and hired other people to support the apps' content and services.

Economist Michael Mandel has analyzed the employment effects of the App Economy in greater detail than anyone. In a February 2012 study, Mandel found that by the fourth quarter of 2011 apps supported employment of 466,000 Americans. Mandel's newer September 2012 report estimates 519,000 App Economy jobs in the U.S. as of April 2012. The two studies use different methodologies, so the two figures are not directly comparable, but it's clear the employment effects of apps are large.

In analyzing these employment effects recently, the *New York Times* also showed that many apps and app-developers don't succeed. They invest lots of time and money, often for naught. "Despite the rumors of hordes of hip programmers starting million-dollar businesses from their kitchen tables," wrote the *Times*,

> "only a small minority of developers actually make a living by creating their own apps, according to surveys and experts. The Grimeses began their venture with high hopes, but their apps, most of them for toddlers, did not come quickly enough or sell fast enough.
>
> "And programming is not a skill that just anyone can learn. While people already employed in tech jobs have added app writing to their résumés, the profession offers few options to most unemployed, underemployed and discouraged workers.
>
> "One success story is Ethan Nicholas, who earned more than $1 million in 2009 after writing a game for the iPhone. But he says the app writing world has experienced tectonic shifts since then.
>
> "'Can someone drop everything and start writing apps? Sure,' said Mr. Nicholas, 34, who quit his job to write apps after iShoot, an artillery game, became a sensation. 'Can they start writing good apps? Not often, no. I got lucky with iShoot, because back then a decent app could still be successful. But competition is fierce nowadays, and decent isn't good enough.'"

But this kind of churn, uncertainty, competition, failure, and possible wild success is a necessary and unsurprising occurrence in a burgeoning entrepreneurial sector. Firms like Code Academy and Menlo App Academy (the

latter founded by two 13-year olds) are teaching wider circles of people, often non-programmers and adolescents, how to build apps. Software will be a growing part of the economy for decades to come. These skills are important – they are the kind of knowledge skills of which we say we need more.

The mobile ecosystem will evolve. But already we know it is an important foundation for the economy. It is a Knowledge Platform. Knowledge Platforms expand the choices and possibilities of wider circles of people. Gutenberg's press was a platform for content distribution and thus accelerated reading *and writing*. The Internet is of course a Knowledge Platform. Even the Industrial Revolution was a Knowledge Platform because new knowledge of mechanical power freed the masses to focus not only on agriculture but endless new products, projects, and previously unknown arenas of learning – in and outside of commerce.

The possibilities of this new Knowledge Platform are far-reaching. They range from mundane daily practicalities to Sci-Fi wonders. There is Square, a project of Twitter co-founder Jack Dorsey, which now processes $10 billion of annualized transactions and is disrupting the major credit/debit card paradigm. Then there is the Tricorder X-Prize, which set as a goal the invention of a full-featured medical diagnostic device in your hand, like the Star Trek "tricorder." In recent days, reports have emerged of major advances in using imagery of our inner eyes and analysis of our breath to diagnose broad ranges of conditions and infirmities. These possibilities show the Tricorder may not be fantasy.

An old saw of the PC era was, "What Intel giveth, Microsoft taketh away."

The glass-half-empty view said that Intel's hardware advances were inert. As Intel delivered ever-more transistors at a Moore's law pace, with ever-faster frequencies, Microsoft would – just as fast – design ever-larger software programs, crammed with new features (and bugs) that would eat up all the new transistors and produce a technological stalemate.

This view, however, was wrong. One of Microsoft's great acts was to creatively "waste" the abundant transistors Intel was putting in each new generation of microprocessors. Yes, the result was often bloated software. But their was no stalemate. The overall advance of the digital economy was rapid, even transformative.

In same way that Microsoft expanded its software to exploit each new microchip miracle, apps will grow to consume the available computer and communications power of the mobile ecosystem. Apps, however, are not only limited to the resources of a device and its wireless link.

Unlike the Wintel union, as powerful as it was, apps are not constrained by the innovations of just two companies or a computer under your desk. It is true, because of the small form-factor of mobile devices, they are limited in storage, compute, and power budgets. These are relative scarcities. What is abundant and must be exploited, however, is the collective power of the cloud. Apps can call upon (and contribute to) the storage, compute, and information resources of thousands of data centers and billions of smart devices. They will link to exacloud supercomputers, putting petaflops in your palm. They will interact with mobile users across the globe and with every node in your hyper-local environment, from your TV to your pacemaker.

All of this distributed power, however, can only be tapped with more, bigger-bandwidth links – to the cloud and among devices. We will push our devices and networks to the limits – and then beyond. The cycle is nowhere near an end.

Soft Power requires hard investment. **EE**

FCC undermining its own 'straight-forward and easy' spectrum standard

Bret Swanson | *April 22, 2014 6:00 am* | *AEI's Tech Policy Daily*

What are the limits of bureaucratic knowledge, expertise, and judgment? Regardless of one's political orientation, one might think the last decade contained more than enough cases of Beltway hubris to suggest the ceiling on such smarts is much lower than just about anyone thought. This is not necessarily an indictment of the well meaning civil servant, lawmaker, or agency head. The fact is the world is just very complicated – far, far more complicated than we like to admit. It is constantly surprising us in its complexity.

So the Federal Communications Commission's apparent addition of another layer of complexity to its upcoming 600 megahertz spectrum auction is rather startling. Last week, FCC chairman Tom Wheeler announced a staff report suggesting rules that would substantially limit the ability of two firms – AT&T and Verizon – to acquire meaningful spectrum. AT&T said the FCC's new plan might force it out of the auction altogether – and in the process threaten the viability of the whole effort to move more spectrum to higher value uses.

The auction was already being described as the most complex large auction of any type ever attempted. The FCC itself explains the process:

> *The broadcast television spectrum incentive auction will be the first such auction ever conducted and, accordingly, requires a new and unique design. The incentive auction itself will actually be comprised of two separate but interdependent auctions — a reverse auction, which will determine the price at which broadcasters will voluntarily relinquish their spectrum usage rights, and a forward auction, which will determine the price companies are willing to pay for flexible use wireless licenses.*
>
> *The lynchpin joining the reverse and the forward auctions is the 'repacking' process. Repacking involves reorganizing and assigning channels to the remaining broadcast television stations in order to create contiguous blocks of cleared spectrum suitable for flexible use.*
>
> *In order to be successful, each of the components must work together. Ultimately, the reverse auction requires information about how much bidders are willing to pay for spectrum licenses in the forward auction; and the forward auction requires information regarding what spectrum rights were tendered in the reverse auction, and at what price; and each of these depend on efficiently repacking the remaining broadcasters.*

> *Finally, though the processes involved in conducting the incentive auction have complex aspects, the FCC has proposed an overall structure that would place the overwhelming share of the computational burden on the Commission itself. The actual implementation, while it will be thoroughly explained and illustrated in technical documents and rules, is designed to place the complex elements 'under the hood,' with an aim to make participation as straight-forward and easy as possible from the bidder's perspective.*

"Straight-forward and easy." Hmmm.

The new rules would restrict the amount of spectrum on which AT&T and Verizon could bid. If it looks like the spectrum available from the reverse auction is 60 megahertz, for example, the two firms might be able to bid on three of six blocks. If 70 megahertz is available, then four out of seven. Clear, right? But it's far worse than it appears because the new wireless technologies – such as 4G LTE – work best with wider spectrum bands. And the FCC's proposed limitation would dramatically reduce the odds that AT&T or Verizon would actually get a wide enough band to make it worth their while to bid and spend scarce capital.

Because the auction depends on inducing the broadcasters to give up their spectrum in the first place, if two of the largest prospective bidders are limited, or sit out entirely, the whole thing could blow up. Without the two largest bidders, prices are likely to be much lower, and broadcasters might say, no thanks. No broadcaster participation, no new spectrum for new mobile innovations.

The FCC's stated rationale for all this nanomanagement is to steer spectrum to non-AT&T-and-Verizon firms to compete with AT&T and Verizon in rural markets. But other recent policies, such as the mandated data roaming order that forces firms to share their networks at below market rates, have discouraged real facilities-based rural competition. And now the auction policy could reduce the available rural capacity of AT&T and Verizon upon whose networks the data roamers roam. There's not even a guarantee – far from it – that the number three and four mobile firms, Softbank-Sprint and T-Mobile, will even make a bigger rural push. More likely the rural talk is a PR strategy designed simply to prevent their rivals from obtaining spectrum and to lower their own price of acquiring it – likely to be used in urban and suburban areas.

The FCC's intricate theories are just totally confounded by the evidence. In previous auctions, lots of firms of all sizes were able to bid on and obtain spectrum in lots of markets. So too in the secondary markets, where firms buy, sell, and trade spectrum every day. Economists Leslie Marx and Michael Katz have all the numbers.

As I concluded in the San Jose Mercury News last autumn:

> *The likelihood that AT&T and Verizon could corner the market in an anonymous auction is nearly zero. They won't know if they are bidding against one another or against a smaller rival.*

The likelihood that complicated rules could undermine the auction, however, is significant. Fewer bidders, especially large ones, probably means fewer, lower bids. The likely result: less available spectrum, jeopardy for the planned public safety network and a possible slowdown in mobile innovation.

The FCC is about to take a huge risk with a hugely successful U.S. industry. It's also openly favoring and disfavoring specific firms, something U.S. law used to try to avoid. The added irony, although it shouldn't matter in a country that values the Rule of Law, is the favored firms are both foreign and the two disfavored are domestic.

http://www.techpolicydaily.com/communications/fcc-undermining-straight-forward-easy-spectrum-standard/

Complexity kills. Keep it away from the spectrum auctions.

Bret Swanson | *December 3, 2013 6:00 am* | *AEI's Tech Policy Daily*

After three and a half years, the Obamacare website, when it launched on October 1, didn't work. After two months of emergency overhauls, it still doesn't work very well. As the Amazons and Wal-Marts process millions of transactions per day, Healthcare.gov struggles with a few thousand, or any at all.

After the initial launch, President Obama addressed the nation and, while listing a number of problems, made a startling acknowledgment: "What we are also discovering is that insurance is complicated . . . ."

Later, the President acknowledged "the way the federal government does procurement and does IT is just generally not very efficient." And "[We] under-estimated the complexities of building out a website. . ."

The IT problems will eventually be fixed. The economic and political complexities of Obamacare, however, will persist. And they will further delink prices from value and discourage innovation across the health care landscape.

Complexity is spreading, and suppressing the economy. A Bloomberg study found the six largest U.S. banks, between 2008 and August of this year, spent $103 billion on lawyers and related legal expenses. Thank you, Messrs. Dodd and Frank.

The Administration now says Healthcare.gov is operating with "private sector velocity and effectiveness." But why seek to further governmentalize one-sixth of the economy if the private sector is faster and more effective than government?

We emphasize this crisis of complexity because the Federal Communications Commission faces a key policy decision, one that hinges on this question. The FCC is contemplating rules for the most important auction of wireless spectrum since 2008, one that seeks to move underused broadcast TV spectrum toward higher value uses, like mobile broadband. Even in its most basic form, this "incentive auction" would be a complex, two-part affair. TV broadcasters will be asked to "bid" on a price to give up their spectrum. And mobile service providers will bid to acquire that spectrum.

The Department of Justice, however, has urged the FCC to effectively exclude the two largest bidders, AT&T and Verizon. Such a policy would not only hurt those two firms' mobile customers who want fast service at reasonable prices. The exclusion could also throw the whole auction into question. With fewer large bidders, the TV broadcasters may not get the prices they're looking for, and the amount of spectrum auctioned could plummet. An auction in which the government picks the winners isn't an auction. (Ronald Coase looks down in disbelief.) What it is is a high-stakes bet that the DOJ and FCC know exactly how the wireless industry should be structured and exactly how this two-side auction will play out.

The private sector is good at mastering complexity and turning it into apparent simplicity — it's the essence of wealth creation. At its best, the government is a neutral arbiter of basic rules. The Administration says it is "discovering" how these "complicated" things can blow up. We'll see if government is capable of learning.

http://www.techpolicydaily.com/communications/complexity-kills-keep-away-spectrum-auctions/

Wireless spectrum: Verizon, AT&T should stay in the auction

By Bret Swanson | Special to the San Jose Mercury News

POSTED: 11/13/2013 10:00:00 AM PST

With Washington dysfunction the story of our time, one might think an easy bipartisan win would make sense for everyone. The opportunity is the wireless spectrum auctions supported by Republicans and Democrats. The mobile Internet industry needs a lot more spectrum; TV broadcasters have spectrum and will sell it for the right price; first responders want an auction-financed wireless public safety network; and the Treasury is set to pocket a hefty sum too.

Everyone wants it, but when and how it happens is up in the air. The reason? More dysfunction courtesy of just two companies (and one government agency) who are proposing complicated rules that could undermine, and even blow up, the auction.

The antitrust division of the Department of Justice argues that the largest mobile service providers, AT&T and Verizon, are in a position to "foreclose" the market for spectrum. DOJ speculates that AT&T and Verizon could discourage other firms from bidding and take all the available TV airwaves for themselves. It wants the Federal Communications Commission to exclude AT&T and Verizon from the auctions or otherwise discourage them from participating.

But DOJ's theory is worse than speculation. It's already been disproved, and Leslie Marx, a Duke professor and former FCC chief economist, has the numbers.

In a new paper, Marx shows that many firms, small and large, participate in auctions and other spectrum transactions and that markets for high-frequency and low-frequency spectrum, and for rural and nonrural, are robust.

In the most recent large spectrum auction -- the 700 MHz auction of 2008 -- the companies now begging for the exclusionary auction rules, Sprint and T-Mobile, did not participate. But in addition to AT&T and Verizon, 99 other parties did. In fact, these other 99 parties won 72 percent of the rural licenses.

In the 2006 auction of AWS spectrum, T-Mobile was the biggest buyer overall and acquired 27 percent of the nonrural licenses. T-Mobile also bought more rural licenses than either AT&T or Verizon. The biggest winners were smaller mobile carriers, who acquired 96 percent of the rural licenses.

The evidence from the secondary spectrum market -- where firms buy, sell and trade existing commercial spectrum -- also undermines DOJ's foreclosure theory. "Since January 2007," Marx writes, "there have been 2,153 transactions of low-frequency spectrum. T-Mobile bought one license and Sprint did not buy any." Other firms bought 2,152 low-frequency licenses. Where were Sprint and T-Mobile?

The surprising fact, given the DOJ's worries, is that Sprint is the reigning king of spectrum, with nearly four times the spectrum-per-customer as its larger rivals. T-Mobile's position is also much improved. Remember, it got an airwave windfall when the government blocked its merger with AT&T, and it also bought MetroPCS.

Given the relatively healthy spectrum positions of the rivals and the active secondary market, the DOJ's attempt to erect obstacles for AT&T and Verizon seems purely punitive. It's dangerous because these companies are attempting to serve customers with ever more voracious appetites for mobile data.

The likelihood that AT&T and Verizon could corner the market in an anonymous auction is nearly zero. They won't know if they are bidding against one another or against a smaller rival.

The likelihood that complicated rules could undermine the auction, however, is significant. Fewer bidders, especially large ones, probably means fewer, lower bids. The likely result: less available spectrum, jeopardy for the planned public safety network and a possible slowdown in mobile innovation.

Bret Swanson is president of the technology research firm Entropy Economics LLC. He wrote this piece for this newspaper.

http://www.mercurynews.com/opinion/ci_24508838/wireless-spectrum-verizon-at-t-should-stay-auction

EVA CLAYTON
Former Congresswoman

April 25, 2014

Committee on Energy and Commerce
House of Representatives
United States Congress
2125 Rayburn House Office Building
Washington, D.C. 20515-6115

Re: Modernizing U.S. Spectrum Policy

Dear Members of the Committee on Energy and Commerce:

In our lifetime, we've witnessed an explosion in the technology and telecommunications space as new devices – only imagined in futuristic movies just a few decades ago – are now commonplace. This technological boom has accelerated advances in nearly every sector of our society including healthcare, education, economics, and transportation. Looking back over the past 50 years, it's incredible to imagine what the next 50 may bring.

However, the values of these new technologies must serve to benefit all Americans. My primary concern throughout my career has been to ensure that underserved and unserved communities have access to the same advantages and opportunities as wealthier communities. As Congress considers an update to the Telecommunications Act, it's important that policymakers and regulators consider the negative impacts certain policies may have on the minority community – while also embracing initiatives that would support underserved families and individuals.

For many Americans in rural and urban communities, the digital divide is a real problem – and as the explosion of technology speeds up – the gap between the technological haves and have-nots will grow exponentially. If this continues, the digital divide will diminish the promise of so many young people in African-American and Hispanic communities.

One way to help accelerate access to connectivity is to grow the amount of available spectrum to wireless companies. Spectrum fuels the mobile devices and services Americans are relying on every day.

As more and more people turn to their smartphones, tablets, and other mobile devices to get access to the Internet, the demand for spectrum rises – particularly in densely populated urban areas. A study by Pew reported that 63 percent of adult cellphone owners now use their device to go online, a figure that has doubled since 2009. And among the African American community 73 percent of users access the Internet from a mobile device.

The government can help solve our spectrum needs in both the short and long term. It should take an active leadership role by identifying ways to repurpose much of its massive spectrum holdings for commercial use, as establishing a long term spectrum pipeline is absolutely critical to consumers and the wireless sector as a whole.

In the short term, the FCC has undertaken an important endeavor to free up more spectrum by conducting groundbreaking incentive auctions. These auctions should be fully open and transparent, as Congress intended, with all interested companies competing in any and all markets they choose. Doing so would ensure that companies who make the significant investment to acquire the spectrum licenses will fully develop that spectrum to the benefit of their consumers.

Beyond the clear consumer benefits, a successful incentive auction will also serve to ensure that the most amount of revenue possible is generated for the U.S. Treasury and the development and deployment of FirstNet. For more than a decade, first responders, including those who respond to tragedies such as hurricanes here in North Carolina, have been promised an interoperable communications system. If the government decides to limit the number of companies who are able compete for the available spectrum it will – most certainly – result in lower net revenues to the government.

In fact, according to Duke University professor economics Dr. Leslie Marx, "Past FCC experience demonstrates that open auctions have generated the most revenue and assigned spectrum to the providers who will put it to work quickly and efficiently for the American public…[and] if spectrum limits had been put in place in the 2008 auction of 700 MHz spectrum it would have reduced auction revenue by 45 percent or almost $9 billion."

In short, if the FCC limits competition in the spectrum auctions it's a lose-lose situation. It's a loss for consumers who could be handed substandard service and it's a loss for the U.S. government – and first responders around the country – that would not be raising the most revenue possible for U.S. taxpayers and programs such as FirstNet.

I would like to thank you for the opportunity to provide you with comments and thoughts surrounding your work in updating our telecoms laws. The government must do all it can to bring more spectrum to market that will hasten the development of next generation technologies that will help all Americans – including minorities – succeed.

Respectfully Submitted,

Congresswoman Eva Clayton (Retired)

117 Northside Drive
Littleton, NC 27850

Response to Committee White Paper

The Fixed Wireless Communications Coalition (FWCC)[1] responds to two issues raised by the Committee on Energy and Commerce in its white paper titled, "Modernizing U.S. Spectrum Policy."

We limit our comments below to fixed, point-to-point microwave services.

8. The FCC further promotes efficient use of spectrum through the build-out requirements and operating rules attached to licenses. Build-out rules require licensees to construct and activate infrastructure within a certain timeframe, or risk losing that license. The operating rules require some licensees to return a license if not used for any 12-month period after construction, promoting the active and continual use of spectrum. These provisions help to ensure that spectrum that is not fully utilized becomes available to those who will put it to dynamic use. Should the Act promote competitive and efficient use of spectrum in this way? How effective is the current Act in doing so? How effectively has the FCC used the tools at its disposal to encourage competition?

The FCC's build-out requirements are working well for site-based licenses, as in the Committee's example above. But they are working badly, and indeed are counter-productive, as to licenses that cover geographic areas, especially those awarded by auction.

Unlike broadcast and mobile phone service, fixed, point-to-point communications do not require spectrum exclusivity. Multiple users can usually coordinate non-interfering point-to-point links in the same region using the same spectrum band. Geographic licensing limits use of the spectrum to only one licensee, which usually must attempt to recover its auction costs by selling service to others. Where demand exists, geographic licensing has allowed the licensee and its customers to deploy quickly and efficiently.

The problem with the FCC's build-out requirements arises with the policies for renewal of geographic licenses in areas where demand is light. To qualify for renewal, after the ten-year license term, the licensee must show it is providing "substantial service," a term the FCC has not

[1] The FWCC is a coalition of companies, associations, and individuals interested in the fixed service—i.e., in terrestrial fixed microwave communications. Our membership includes manufacturers of microwave equipment, fixed microwave engineering firms, licensees of terrestrial fixed microwave systems and their associations, and communications service providers and their associations. The membership also includes railroads, public utilities, petroleum and pipeline entities, public safety agencies, cable TV providers, backhaul providers, and/or their respective associations, communications carriers, and telecommunications attorneys and engineers. Our members build, install, and use both licensed and unlicensed point-to-point, point-to-multipoint, and other fixed wireless systems, in frequency bands from 900 MHz to 95 GHz. For more information, see www.fwcc.us.

clearly defined.[2] A "safe harbor" allows renewal if the licensee has constructed four point-to-point links per million population in the license area. Where the market is not sufficiently developed, this standard creates a perverse incentive for the licensee to build "links to nowhere" using obsolete and useless equipment merely to preserve its license rights. The spectrum remains functionally unused.

If the licensee lacks enough business to support the four-links-per-million standard, and does not play the game of constructing pointless links, the public-interest consequences are worse. The FCC has canceled hundreds of licenses for non-construction despite, in some cases, substantial investments by licensees to prepare the spectrum for offering service. The FCC has never attempted to re-auction that spectrum. Given the renewal policy history, a rational bidder would be unlikely to offer much.

Rather than incentivize licensees' efforts to serve the public interest, the present policy produces exactly the result the FCC most wants to avoid: out-of-service spectrum that no one can use.

An update to the Communications Act could remedy these problems:

1. If Congress continues to favor area-wide auctions for fixed service spectrum, then license renewal standards should better evaluate whether spectrum is under development, using criteria calculated to …

   encourage:

   (a) making the spectrum available to the public through leasing and other industry standard spectrum accessibility platforms,
   (b) offers to build commercially viable networks,
   (c) research and & development, and
   (d) ongoing investment until the market reaches commercial viability, and

   discourage:

   (a) competitive warehousing, and
   (b) the construction of useless links.

2. To promote construction, a licensee should be allowed to continue operating point-to-point links that have already been built, even if the rest of the license is cancelled.

[2] Worse, the FCC has defined "substantial service" circularly: "service which is sound, favorable, and substantially above a level of mediocre service which might minimally warrant renewal." 47 C.F.R. § 101.1011(a). That is, the level of service required for renewal is "substantially above" the level of service required for renewal.

3. After a license is cancelled and beyond all appeals, the affected spectrum should become available for licensing in according to the precepts noted in items 1 and 2 above, and if that is not able to be accomplished, then for shared licensing by anyone.

10. The other governing body of domestic spectrum use is the National Telecommunications and Information Administration (NTIA), which has the authority to assign spectrum frequencies to all federal government owned or operated radio stations under section 305 of the Communications Act. NTIA manages the federal government's use of spectrum, in coordination with the FCC. Distinctions between "federal" or "non-federal" bands of spectrum are administrative creations made through agreements between the FCC and NTIA. The Spectrum Act required NTIA to work with the FCC to identify specific bands for release to commercial use and how to repurpose resources from federal to commercial use, with priority given to options that assign spectrum for exclusive, non-federal use through competitive bidding. In a report on reducing duplication in the federal government, GAO identified spectrum management as 'fragmented' between NTIA and the FCC and urged coordination. What role should NTIA play in the licensing and management of spectrum? Is their current role appropriate and necessary, given the potentially duplicative functions of the FCC and NTIA in spectrum allocation and assignment? (citation footnote omitted)

The FWCC believes the FCC and NTIA should maintain their distinct roles, but supports increased harmonization in areas where they currently work independently.

Harmonization of technical requirements. Fixed microwave equipment performance rules are set out by the FCC in Part 101 (for most bands) and by NTIA in its "Manual of Regulations and Procedures for Federal Radio Frequency Management" (Red Book). Some technical requirements vary between the two. For example, the NTIA's spectrum mask is more stringent than that defined by the FCC. In this example, we believe federal customers could benefit from the higher output power that would be possible if NTIA were to adopt the FCC mask. More generally, harmonization would reduce duplication of work in developing standards within the U.S. government, and improve clarity for equipment vendors who design for both federal and non-federal customers.

Streamlining of radio certification and licensing. The NTIA equivalent of radio certification is far more demanding and time-consuming than the FCC's process. NTIA requires federal agency sponsorship for radio certifications. Once a federal agency develops a need for a particular radio, the manufacturer provides all the specific transmitter and receiver characteristics for the certification. Historically the process from start (sponsor) to finish (NTIA certification) takes six to twelve months, but in some circumstances can take longer. Once certification is complete, then the specific licensing process can begin. Given the accelerated technology advancements in radio systems, the result is that commercial off-the-shelf radios can be nearing end of life by the time systems are implemented. The delays can thus limit a federal user's access to the most

current industry-accepted radio platforms. We strongly encourage a review of streamlining between the NTIA and FCC in the areas of equipment certification and licensing.

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April 25, 2014.

Response to Questions in the Second White Paper

"Modernizing U.S. Spectrum Policy"

by

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and

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Richard A. Epstein, New York University Law School
Justin (Gus) Hurwitz, University of Nebraska College of Law
Daniel Lyons, Boston College Law School
Bruce M. Owen, Stanford University
Richard J. Pierce, Jr., George Washington University School of Law
James B. Speta, Northwestern University Law School

before the Committee on Energy and Commerce

U.S. House of Representatives

April 25, 2014

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I. Introduction and Summary

At the outset, we want to again commend the Committee for initiating this process to review and update the current Communications Act. As we said in our initial Response, the review is timely because, as a result of technological advances and dramatic marketplace changes, many of which were described in our first Response,[1] the Communications Act does need updating. And, as part of that process, there is no doubt that spectrum policy needs "modernizing" too.

In preparing this Response, our focus is on offering general principles that should guide Congress's consideration in drafting a modernized approach to spectrum policy and the Federal Communications Commission's approach to implementing such a modernized policy. While the Committee's white paper presents a number of questions on specific

[*] While the signatories to this Response are in general agreement, of course, with the views expressed in these comments, their participation as signatories should not necessarily be taken as agreement on every aspect of the submission. And the views expressed are those of the individuals, and they should not be attributed to the institutions with which they are identified.

[1] Free State Foundation Response to Questions in the First White Paper, "Modernizing the Communications Act," January 31, 2014, *available at*: http://www.freestatefoundation.org/images/Response_to_Questions_in_the_First_White_Paper_013114.pdf

topics, we believe, at least at this stage, that the generalized framework presented in these comments offers a more useful approach in responding holistically to the questions than would individual responses to specific questions. Indeed, this approach is consistent with a central theme of our comments: spectrum policy is undergoing its own "convergence" of sorts, and a proper policy framework for spectrum should encourage and anticipate this convergence on a uniform, integrated basis.

To briefly summarize our views: The current administrative fiat approach has its roots in the Radio Act of 1912, which was passed in the wake of the Titanic disaster. It vested authority to issue licenses for wireless communications in the Secretary of Commerce as a means of mitigating interference. After radio broadcast stations began operating in the 1920s – and their broadcasts on the same or nearby frequencies began to interfere with each other – Congress passed the Radio Act of 1927,[2] which created the Federal Radio Commission ("FRC"). The FRC was succeeded, largely without change, by the Federal Communications Commission ("FCC") with the passage of the Communications Act of 1934.[3]

The basic structure of spectrum regulation, which was initially formulated over 100 years ago and has remained largely the same since adoption of the Radio Act of 1927, is based on technological, economic, and legal views that no longer make sense – to the extent they ever did. It is true that in the past two decades there have been some changes, such as the initiation of auctions to award spectrum licenses, which represent positive steps toward a more market-oriented regime. Nevertheless, a key feature of the administrative model that has prevailed in the last century, and which largely continues to

[2] Pub. Law No. 632, ch. 169, 44 Stat.1162 (1927).
[3] Pub. Law No. 416, ch. 652, 48 Stat. 1064 (1934).

prevail today, relies on allocation by the FCC of particular frequency bands for particular pre-specified service uses in accordance with particular pre-specified technical parameters. This process requires the use of extensive, and often pointless and redundant administrative procedures that have long outlived their usefulness. Regrettably, this "command-and-control" administrative regime dramatically fails to promote flexible use of spectrum. As economics scholar Thomas Hazlett, a former FCC Chief Economist and a leading authority on spectrum policy, has explained, "[t]he weakness of the administrative allocation regime is that it regularly resolves potential conflicts among wireless users by suppressing vast amounts of productive activity."[4] Over the past few decades, there have been substantial technological changes, including the advent of digital wireless communications, which have been coupled with the adoption of auctions as the preferred method for the initial assignment of licenses. These developments conclusively show that, whatever the (dubious) rationale for the traditional command-and-control administrative regime in the last century, that rationale no longer has any contemporary relevance.

A modern approach to spectrum policy should abrogate the existing framework and replace it with a system that fosters a robust market in which spectrum rights can be freely traded largely independent of any FCC administrative control. To be sure, any new system of spectrum management will require some transitional periods and mechanisms, but the transitional costs are well worth bearing. Under this market-oriented replacement model, the FCC will still retain a role in spectrum management, albeit a much more limited one, primarily as the operator of a rights-clearinghouse akin to a registrar of

[4] Thomas W. Hazlett, *A Law and Economics Approach to Spectrum Property Rights, A Response to Weiser and Hatfield*, 15 GEO. MASON L. REV. 975, 977 (2008).

deeds. The FCC's role would be reduced to performing a modest "zoning" function where necessitated by clear coordination problems and where necessary, in limited special circumstances, to address special needs such as assuring public safety.

There is a widespread, indeed, almost unanimous, consensus among economists and policy experts that a market system that allows flexible use of spectrum is the best way to achieve the most efficient allocation of most resources. This fundamental proposition holds true for the spectrum resource as well – just as Nobel Laureate Ronald Coase contended in 1959 in his famous article, *The Federal Communications Commission*.[5] Coase showed that clearly delineated property rights and market forces, not government control, would lead to the most efficient allocation of the spectrum resource.[6] Again, during the past two decades, Congress and the FCC have taken some steps towards implementing a more market-oriented regime. Now, as Congress considers updating the Communications Act, any new policy framework must clearly support and foster a market in spectrum property rights, which relies on unencumbered auctions to make the initial assignments of spectrum rights, which thereafter should be freely tradable in the secondary market.

II. Spectrum Regulation in the 20th Century

The FCC's role in regulating spectrum in the 20th century was very different from what it should be today. Our understanding of the spectrum throughout much of the last century, when its uses were more rudimentary and based on far simpler, less efficient

[5] R. H. Coase, *The Federal Communications Commission*, 2 J. L. & ECON. 1 (1959).
[6] As Thomas Hazlett explains, just a year after publication of Coase's *FCC* work, in *The Problem of Social Cost* Coase "demonstrated that resources would be efficiently allocated if rights to property were well-defined and the cost of trading these rights was modest." Thomas W. Hazlett, *Spectrum Tragedies*, 22 YALE J. ON REGULATION 242, 244 (2005), commenting on, Ronald H. Coase, The *Problem of Social Cost*, 3 J. L. & ECON. 1(1960).

technologies, was limited compared to today. To be sure, early on some core uses constituted essential services – most notably ship-to-ship and ship-to-shore radio and other radio transmissions needed for emergency services. In this setting, the Federal Radio Commission, beginning in 1927, and then the FCC, which succeeded the FRC in 1934, served two primary functions: to allocate spectrum in specified frequency bands for specified service uses, and within such allocated bands, to assign frequencies to particular users and ensure that such users did not interfere with each other and (especially) with essential services.

It should be noted that the rationale for this form of administrative command-and-control regulation was weak even then. Prior to the establishment of the FRC, the Radio Act of 1912 required the Secretary of Commerce to issue licenses as a matter of right. Under this system, and prior to the creation of the FRC, courts were already developing workable common law rules to govern rights in spectrum.[7] The transition away from a system that relied on first possession to establish rights to pervasive regulation of the allocation, transfer, and use of spectrum introduced myriad inefficiencies. As noted above, Ronald Coase's study of these inefficiencies led directly to the development of his Nobel-winning work on externalities and his argument that the government should embrace market-like competitive bidding systems (e.g., auctions) to allocate spectrum.[8] While Coase was often dismissed as a heretic in 1959, no one today seriously argues against the superiority of auctions for allocating spectrum. The other alternatives –

[7] See *Tribune Co. v. Oak Leaves Broadcasting Co*. This 1926 Illinois state court decision is reprinted in CONG. REC. – SENATE 215-219 (Dec. 10, 1926). For a good discussion of the *Oak Leaves* case and related common law developments regarding spectrum property rights before the Federal Radio Act was enacted in 1927, see Thomas W. Hazlett, *The Rationality of U.S. Regulation of the Broadcast Spectrum*, 33 J. L. & ECON. 133, 148-152 (1990).

[8] R. H. Coase, *The Federal Communications Commission*, 2 J. L. & ECON. 1 (1959).

comparative administrative hearings and lotteries – consume vast resources to locate spectrum in the wrong hands. Comparative hearings present major public choice concerns because they are an open invitation for never-ending opportunities for lobbying and jockeying in efforts to get the FCC to adopt favorable decisional criteria or other advantages impacting the selection.[9]

Whatever the case that existed for regulation of spectrum in the 20th century, today it is far weaker. Decades of experience with the FCC's various regulatory modalities have demonstrated the weaknesses of command-and-control regulatory methods relative to market mechanisms that rest on property rights and voluntary contract to allocate spectrum use. Indeed, the correct choices are even more critical today because recent technological advances – particularly the development of spread-spectrum, digital, cellular technology – make it possible to coordinate spectrum use on highly efficient platforms that are relatively resilient to interference. The more intensive use of underutilized spectrum thus increases the overall carrying capacity of the system, which could prove critical for the data-intensive uses of the future.

A consequence of these advances is that spectrum applications have been undergoing convergence. Earlier, broadcast radio and television, satellite communications, point-to-point microwave, and cellular technologies were developed using unique analog encoding and transmission technologies. Today they all increasingly rely on similar technologies to transmit digital data. Just as there is broad consensus that

[9] Lotteries avoid some of the public choice problems plaguing comparative hearings. But they suffer from the serious disadvantage that, unlike auctions, they do not allow the functioning of market-based price signals to determine the highest, best use of the spectrum. To the extent that the FCC is not committed to rules that promote unencumbered "clean" auctions – and it certainly hasn't always been so committed – auctions too are subject to public choice concerns as potential bidders lobby to obtain auction rules that favor themselves relative to their rivals.

the silos created by Titles II, III, and VI of the Communications Act are obsolete today, disparate treatment of different spectrum applications within the FCC or between the FCC and other agencies are obsolete and should be phased out.

Over roughly the past 30 years, since the advent of the first cellular and digital technologies, the FCC and Congress increasingly have turned to liberalized and flexible-use licenses, and market-like auctions to allocate them.[10] This welcome development should be prologue to a modernized spectrum policy: the Communications Act review and update is an opportunity to complete and normalize the transition away from the 20th century command-and-control spectrum policy to a market-oriented 21st century policy premised on flexible use and freely transferable spectrum rights.

Here are some concrete applications of the general theory.

III. Changing Understandings of Spectrum

As in other areas of telecommunications regulation, the convergence of once disparate end uses has largely been driven by digitalization. An ever increasing amount of content, now well over half, is distributed wirelessly now encoded in digital form, transmitted by digital signals. As technology continues to advance, the movement toward ubiquitous digitalization – and, hence, toward further convergence – almost certainly will gain momentum.

That technological convergence to digital will make each band of spectrum a closer substitute to all the others for facilitating the transmission of all forms of information. Convergence increasingly allows spectrum initially tasked to one purpose

[10] It is important to observe, however, that even when the FCC has implemented auctions to award spectrum frequencies, it too often has encumbered the auctions with various conditions designed to tilt the auction results one way or the other or to favor certain bidders, say, by use of bidding credits or requiring certain modes of operation. Encumbering auctions with conditions obviously compromises the market-based price-setting function of the auctions.

(e.g., distributing television signals) to be converted to other purposes for which it is equally suited (e.g., wireless data transmission). Of course, sometimes the physical attributes relating to specific bands of spectrum (e.g., how it propagates) may render certain bands more or less suited to specific tasks – concerns that are discussed below. But by and large, technological convergence of spectrum use will lead to greater substitutability across the entire spectrum. The new legal regime should be flexible enough to respond to unanticipated technical changes without having to undertake case-by-case reallocation of spectrum across different uses.

In other words, just as "data is data is data," increasingly "spectrum is spectrum is spectrum." While spectrum may never be fully commoditized, across a broad range of present and future applications, including the majority of actual current uses, spectrum is largely fungible. It is hard to justify any substantial regulation of near-commodity goods.

Over time the amount of spectrum needed for any given application has decreased dramatically. In part this is due to digitalization and increasingly sophisticated compression algorithms. The technology that we use to transmit signals is also far more precise, resulting in less signal “bleed” from one band into adjacent bands. For example, spread spectrum technology yields signals that are less subject to interference from other sources and that are less likely to cause interference to other sources.

These technological changes mean that any given application requires substantially less spectrum today than was required just ten or twenty years ago. Of course, this doesn’t mean that spectrum is any less "scarce" today than it was then, given that new uses will create heavy demands for spectrum released from traditional uses. Taken as a whole, these changes only mean spectrum use today is much “thicker” and

more robust than just a few years ago: at least in principle, many more buyers should be able to participate in the market, each seeking much smaller spectrum allocations than ever before. This is particularly true when we consider "over the top" applications – applications such as Internet-based radio stations, which "transmit" their signals as data over another data network, without requiring a separate spectrum allocation.

The changes over the past 100 years are likely to be exceeded over the next 100 years. Spectrum policy for the 21st century should enable the next century's worth of development on such matters as multicast and broadcast-like content distribution over cellular networks; advances in MIMO (multiple-input and multiple-output) and related technologies, which already are increasing the capacity of existing networks by orders of magnitude; and the latest research in the use of millimeter-wave frequencies for high-speed data transmission.

Similarly, the increasingly powerful "software-defined radio" technologies promise major improvements, especially when combined with wideband radios and variable-frequency oscillators. Historically, each piece of equipment had to be designed to specific applications and frequencies. Newer technologies, however, allow receivers to be manufactured to operate on a very wide range of frequencies – the specific frequencies to be used are selected by software at run-time. For regulatory purposes, this one key change has the potential to sever the historic ties between frequency allocation, licensed uses, and hardware.[11]

[11] The point of discussing some of the current and anticipated technological advances in the last two paragraphs is not to suggest that policymakers should be engineers and understand their intricacies. Rather the point is to show that these advances are consistent with – indeed, strongly bolster the case for – adoption of the flexible use, market-based regime proposed in these comments.

IV. A 21st Century FCC Spectrum Policy

Even with these changing circumstances, there remains a role for the FCC to play in a 21st century spectrum policy. Broadly speaking, the FCC should transition from its historical command-and-control administrative role of allocating spectrum for specific uses and assigning frequencies to specific users to a regime that facilitates a free market that lets spectrum users purchase, mortgage, lease, and share spectrum in accordance with their own business plans. This transition is akin to that of the westward expansion of the United States: in the early years, land was given away in large allocations, to create incentives for private parties to develop new uses and unlock natural resources. Once the land had been mapped, land ownership and use thereafter could be coordinated by the market. Similarly, the first century of spectrum policy allocated broad swaths of spectrum to individual uses and users to develop new technologies and resources; in its second century, there is no need to remain fixated on "high-frequency expansion" to map out the basic contours of the usable spectrum. Today's urgent need is to organize an orderly transition so that the FCC's role will be akin to a "recorder of deeds" that facilitates market transactions.

Making this *transition* requires some specific changes to the FCC's current approach to spectrum regulation. Some of these will be of limited duration and will give way as robust markets displace the existing command-and-control regime.

First, as suggested above, the convergence in use through convergent technologies militates in favor of parallel structural convergence. Within the FCC, this means consolidating bureau functions relating to spectrum (e.g., from the Media, Wireless, and

International Bureaus). Beyond the FCC, it means rationalizing the spectrum management functions of the Commission and NTIA.

Thus, excepting special circumstances, relating, for example, to national security or public safety, the government should yield voluntarily its control over the spectrum resource, except perhaps for that spectrum that it wishes to retain for its own use. For spectrum that it wishes to retain, the government should have to pay market prices so that, for greater transparency, its own costs are on-budget. But, even here, the government should consider leasing spectrum from the private market to satisfy its service needs. The private sector has greater expertise in developing and deploying wireless networks. Competitive forces – which are increased with federal, state, and local governments as customers – are more likely to ensure those networks are technologically current and economically efficient. Supporting government users' specific needs could lead to development of new consumer-benefitting technologies. They could also exploit important economies of scale that would benefit both consumer and government users.

Second, while there may remain some limited role in rare cases for the Commission to zone spectrum for specific uses which depend on distinctive technical characteristics of transmission, the government otherwise should not hold back spectrum for general uses unless it is prepared to bid in the market against others. And the FCC should move away from regulator-defined protective "guard" bands. Where a given use requires the "extra" protection of a guard band that effectively encumbers adjacent spectrum, the licensee should internalize that cost.

Third, the Commission's approach to unlicensed spectrum needs substantially more theoretical development. While our presumption favors licensed spectrum to

promote economic development, an emerging consensus now thinks spectrum policy should embrace both licensed and unlicensed spectrum uses. But the understanding of how that insight is put into operation today, or in the near future, is underdeveloped. So-called unlicensed spectrum today is not actually "unlicensed": its use requires compliance with various requirements imposed by the FCC and industry standards groups. The purpose of these requirements is to mitigate interference and manage scarcity. Users of unlicensed spectrum incur the costs of complying with these requirements and, even when they comply, they still face the risk of congestion.

Importantly, the unlicensed model faces an open question over what happens should its users face scarcity, which could happen if the approach is so widely adopted that its technological approach to scarcity mitigation fails. Should this point of saturation not be reached, licensed and unlicensed spectrum will start to resemble each other: both offer users exclusive use of spectrum; the boundaries of that spectrum are merely being delineated along different dimensions in exchange for either a license fee or the cost of technological compliance. If unlicensed spectrum becomes so popular that its users face scarcity, it is unclear how the Commission would or should respond to this new tragedy of the commons.[12]

Fourth, a proper 21st century spectrum policy will account for the role of receiver design. This discussion results in large part from the social losses that stemmed from the FCC's revocation of LightSquared's permit to deploy a terrestrial data network on

[12] As discussed in the FCC's 2002 Spectrum Policy Task Force Report, there is an "important caveat" to unlicensed models. In that report, the Commission observed that: "An important caveat must accompany any recommendation for a commons model: although there are indications that technology can go a long way to forestall scarcity concerns, if scarcity eventually does arise in particular spectrum bands in the future, then the commons model may need to evolve to address the problem." FCC Spectrum Policy Task Force, *Report of the Spectrum Rights and Responsibilities Working Group* (November 15, 2002).

spectrum adjacent to that used by GPS systems. The issue also ties into the earlier discussion of software-defined radio and issues about congestion on unlicensed spectrum. In the context of the LightSquared matter it is worth stressing that GPS receivers have long been manufactured on the assumption that spectrum adjacent to that used by the GPS system would only be used, if at all, for low-power satellite applications. By the same token, at no point did the GPS users secure any restrictive covenant or other restriction that would confine LightSquared to limited uses on its own spectrum before LightSquared had acquired the spectrum and spent substantial sums developing it.[13]

The general point is that, in a world of readily-transferred flexible-use licenses, hardware manufacturers' decisions about receiver design should not be allowed to hamper or block the otherwise efficient operation of spectrum markets. Software-defined radio and related technologies increasingly give manufacturers the ability to design their receivers in a versatile way so that they are not tied to specific frequencies, encoding schemes, or protocols. A 21st century free market-oriented spectrum policy such as that proposed here would have encouraged the prompt resolution of the LightSquared – GPS receiver issue in a way that would have mitigated the sizeable social losses that have been incurred as a result of the FCC remaining mired in the throes of the traditional administrative fiat regime. As the LightSquared situation illustrates, the current FCC licensing regime discourages market-based transactions that would allow spectrum to be put to productive use in a way that enhances overall consumer welfare.

[13] On the LightSquared – GPS interference situation, see Thomas W. Hazlett, *Tragedy of the Regulatory Commons: LightSquared and the Missing Spectrum Rights*, DUKE LAW AND TECHNOLOGY REVIEW (forthcoming).

V. Conclusion

As the Committee moves forward with its review and update process, especially regarding spectrum policy, we urge it to carefully consider and implement the views expressed in this Response.

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April 25, 2014

Wayne Winegarden, Ph.D.
933 N. Kenmore Street
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Members of the Panel,

Thank you for the opportunity to submit comments regarding the importance of maintaining an open spectrum auction. The House Committee on Energy and Commerce has correctly recognized that the Communications Act, the foundation of U.S. regulatory policy toward the communication and technology sectors, is outdated.

The over-arching problem of the current Communications Act is the arbitrary industry silos the Act creates. These regulatory silos "pre-determine" too much of the competitive process, imposing unnecessary costs and operating restrictions on some parts of the industry that are not applicable to all parts of the industry.

The Committee's commitment to address the problems of the Communications Act is correct. However, in addressing the current flaws of the Act, it is important to recognize that disparate treatment of different parts of the industry is part of the current regulatory environment's problem. As a consequence, it is imperative that the reform process does not repeat these mistakes. In particular, current suggestions to restrict who can participate in the upcoming spectrum auction, or how potential bidders can participate in the auction process, should be rejected.

Efficient use of the nation's broadband infrastructure is creating tremendous benefits to the U.S. economy. According to the CTIA, the U.S. wireless industry created 1.6 million new jobs between 2007 and 2011 – a time when overall private sector jobs fell by 5.3 million jobs.[1] Faster, more reliable, broadband service also plays an important role raising workers' productivity and increasing consumers' enjoyment of their leisure time. An efficient auction process enhances these benefits by ensuring that the spectrum is allocated to its highest valued users.

An open auction process empowers potential users to express how much they value the spectrum based on how much money they are willing to bid for the right to use the spectrum. It is through this process that we discover the spectrum's value to society. While current estimates value the broadcast spectrum at $36 billion, its actual value might be much higher (or much lower). Until the potential users of the spectrum are allowed to compete with one another through an open and fair auction process, we will not know the answer to this question. Placing arbitrary restrictions on who can participate in the spectrum auction diminishes the ability of the auction to allocate the spectrum to its most highly valued uses. Consequently, this crucial economic asset will be under-utilized, negatively impacting the welfare of consumers and the economy's rate of growth.

The other purpose of holding the auction is the revenues raised. The previous spectrum auction in 2008 raised $19 billion – not a trivial amount. Imposing restrictions on who can participate in the spectrum auction will reduce the amount of revenue the Treasury will raise. As any economics 101 student should know, if demand falls when supply is fixed, then market prices decline. Applying this simple logic to the spectrum auction, restrictions on who can bid for the spectrum (the demanders in this market) given a fixed supply of spectrum being auctioned off (the supply in this market) will lead to less revenue raised by the FCC, not more as some proponents are erroneously claiming.

[1] CTIA – The Wireless Association, "Letter to Federal Communications Commission" (GN Docket No. 09-51, WT Docket No. 13-135), November 13, 2013.

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In light of these considerations, I would urge the Committee to reject any proposals to impose arbitrary restrictions on who can participate in the auction or how they can participate. The Committee should recognize that the broadband spectrum is an incredibly valuable economic asset, and that this asset will be employed by its most effective users only if the auction process is open, fair, and allows all potential users to compete.

Thank you for your time and consideration of my comments.

Sincerely,

Wayne Winegarden, Ph.D.
Contributing Editor, EconoSTATS at George Mason University
Sr. Fellow in Business and Economics, Pacific Research Institute

MERCATUS CENTER
George Mason University

April 25, 2014

Representatives Fred Upton and Greg Walden
Energy & Commerce Committee
United States House of Representatives

Dear Chairman Upton and Chairman Walden:

Thank you for the opportunity to respond to the committee's questions on these important topics. The Technology Policy Program of the Mercatus Center at George Mason University is dedicated to advancing knowledge about the effects of regulation on society. As part of its mission, the program conducts careful and independent analyses that employ contemporary economic scholarship to assess legislation and regulation from the perspective of the public interest. Therefore, this response does not represent the views of any particular affected party but is designed to assist Congress as it explores these issues.

Please find my responses to some of your spectrum policy questions attached below. The Mercatus Center has published scholarship on communications law reform for several years. The scholars in our Technology Policy Program and our affiliated scholars would be happy to elaborate on communications policy recommendations, should the opportunity arise.

Thank you for initiating discussion about updating the Communications Act and United States spectrum policy. Policy reform can give America's spectrum-dependent technology and telecommunications sectors a predictable and technology-neutral legal framework. When Congress replaces command-and-control rules with market forces, consumers will be the primary beneficiaries.

Sincerely,

Brent Skorup
Research Fellow, Technology Policy Program
Mercatus Center at George Mason University

Federal Spectrum Policy

Former senior Federal Communications Commission (FCC) officials Gerald Faulhaber and David Farber noted without irony that US spectrum policy resembles GOSPLAN, the Soviet planning agency that distributed scarce inputs to producers in every sector of the Soviet economy.[1] The woeful inefficiencies and waste resulting from the current system of regulatory allocation are predictable, yet avoidable.

It is unfortunate that Congress and the FCC have largely permitted the tremendous waste of spectrum resources for decades instead of freeing most spectrum for allocation via market processes. The US spectrum industrial policy, surviving mostly unevolved since 1927, severely distorts the 21st century technology industry and penalizes consumers with higher prices, less effective wireless competition, and fewer innovative devices.

Congress has made some efforts to liberalize spectrum allocation and has permitted auctions for some bands since 1993. The FCC, also, has permitted more so-called flexible use allocations, which allow licensees to use their wireless assets for essentially any commercially viable service. This liberalization, while welcome, is insufficient and incremental. Freeing most or all commercial spectrum would unleash waves of investment and technological innovation. There is no technical reason why the FCC needs to define, after years of deliberation and reams of rules, whether bands are used for, say, satellite television and not smartphones or GPS or taxi dispatch radios. The finite amount of spectrum does not necessitate government allocation any more than the finite amount of beef, wheat, and vegetables requires the government allocation of groceries.[2] Spectrum is an input, just like any other, that firms can combine, lease, and sublease in incalculable and innovative ways to bring services to businesses and consumers. Liberalizing spectrum rules would allow businesses and consumers to enjoy these benefits.

> **2. There is vigorous debate over the appropriate role for unlicensed spectrum in the wireless ecosystem, particularly following the passage of the Spectrum Act. The Act requires the FCC to auction all spectrum made available by the incentive auction, but allows for unlicensed use in guard bands. Some contend that there is an ample amount of unlicensed spectrum available and that assigning spectrum via exclusive licensing is the most effective, efficient, and economically responsible way to allocate spectrum. Others argue that repurposed spectrum should be allocated for unlicensed use for similar reasons. What role should unlicensed spectrum play in the wireless ecosystem? How should unlicensed spectrum be allocated and managed for long-term sustainability and flexibility?**

There are several economic coordination problems posed by unlicensed spectrum that largely do not apply to licensed bands.[3] The first is that the most useful unlicensed bands often become

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[1] Gerald R. Faulhaber & David Farber, "Spectrum Management: Property Rights, Markets, and the Commons" (Telecommunications Policy Research Conference Proceedings, 2002), 5, http://assets.wharton.upenn.edu/~faulhabe/SPECTRUM_MANAGEMENTv51.pdf (citations omitted).

[2] See Ronald H. Coase, "The Federal Communications Commission," *Journal of Law & Economics* 2 (1959): 1–14.

[3] This comment is not arguing for zero unlicensed spectrum. The analysis is intended to illustrate costly issues frequently ignored by or unknown to participants in spectrum policy discussions.

filled with devices competing for transmissions—a situation approaching a tragedy of the commons[4]—creating the need for even more unlicensed bands. In the 2.4 GHz band, for example, so many devices—like Bluetooth devices, cordless phones, and baby monitors—are using the spectrum that technology experts advise consumers to avoid 2.4 GHz and use devices on other unlicensed bands.[5] Cisco, a major producer of network equipment for unlicensed uses, regards unlicensed spectrum as "a great success so far" but likewise remarks upon the three most popular unlicensed bands that, "Just as everyone moved from 900 MHz to 2.4 GHz to avoid interference, the 'band jumping' effect will catch up with 5 GHz."[6]

In contrast, overuse is significantly mitigated in licensed bands since congestion and dropped signals are bad for business. Flexible use licensed bands[7]—like those used for smartphones and cellphones—also become congested as devices and applications drive more consumer demand. Licensed bands, however, permit licensees to mitigate spectrum congestion through technology improvements—say, from analog to digital transmissions and from 3G to more efficient 4G LTE—and through incentivizing device replacement.

T-Mobile, for instance, after acquiring smaller carrier MetroPCS in 2013, migrated 3.5 million MetroPCS customers off of MetroPCS's aging and congested network and onto T-Mobile's more efficient 4G networks through a phone replacement program.[8] This freed up spectrum for new and existing T-Mobile customers since MetroPCS devices were no longer in use. Remarkably, T-Mobile upgraded users' devices and repurposed MetroPCS's 1900 MHz spectrum assets in a matter of months.[9]

There is no analogous example, to my knowledge, of spectrum-clearing in unlicensed bands. Indeed, contrast T-Mobile's repurposing of MetroPCS spectrum with the interference-prone 900 MHz and 2.4 GHz unlicensed bands, where sometimes decades-old baby monitors and cordless phones are still used, in addition to newer wifi and Bluetooth devices. Short of going door-to-door nationwide to retrieve those devices, those bands will be overcrowded with interfering devices for the foreseeable future.

Unlicensed spectrum and devices create substantial consumer and economic value. However, the benefits of unlicensed spectrum are only one side of the ledger. Allocating unlicensed spectrum means not only forgone auction revenue in a time of strained federal budgets, but

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[4] See also Jerry Brito, "The Spectrum Commons in Theory and Practice," *Stanford Technology Law Review* 2007 (2007).

[5] Lisa Phifer, "Abandoning the 2.4 GHz junk band – Moving Wi-Fi to 5 GHz," *Webtorials*, May 2013, http://www.webtorials.com /content/2013/05/abandoning-the-24-ghz-junk-band---moving-wi-fi-to-5-ghz.html ("It's time to start weaning legacy devices off the 2.4 GHz junkband [sic], using reduced 2.4 capacity, band-steering and better performance at 5 GHz as carrots to speed that migration."); Glenn Fleishman, "Understanding Wi-Fi's Two Spectrum Bands," *PCWorld*, May 20, 2009, http://www.pcworld.com/article/165240
/article.html (advising wifi users to switch their Apple devices from the 2.4 GHz unlicensed band to the less-congested 5 GHz unlicensed band).

[6] Cisco, "20 Myths of Wi-Fi Interference," available at http://www.cisco.com/c/en/us/products/collateral/wireless/spectrum-expert -wi-fi/prod_white_paper0900aecd807395a9.pdf.

[7] "Licensed bands," in this context, should be construed as "flexible use licensed bands."

[8] Mike Dano, "T-Mobile Notches 1.6M New Subs in Q4, Will Shutter 3 MetroPCS CDMA Markets This Year," *Fierce Wireless*, February 25, 2014, http://www.fiercewireless.com/story/t-mobile-notches-16m-new-subs-q4-will-shutter-3-metropcs-cdma-markets-year/2014
-02-25; T-Mobile, "Migration of MetroPCS Customers to Nationwide 4G HSPA+ and LTE Network Ahead of Schedule," news release, June 14, 2013, http://newsroom.t-mobile.com/phoenix.zhtml?c=251624&p=irol-newsarticle&ID=1829966.

[9] Dano, "T-Mobile Notches 1.6M New Subs," February 25, 2014.

also foregoing the social and economic value of licensed, flexible-use allocation, which is substantial.[10] These realities led senior FCC policy advisors Evan Kwerel and John Williams to conclude,

> Some special administrative provisions for low-powered devices may be efficient in a market system. However, in making decisions about the amount of spectrum allocated to unlicensed use, the government should face the opportunity cost of limiting or foreclosing other use . . . . Future expansion of dedicated spectrum for unlicensed use could be obtained through . . . a licensee . . . charg[ing] manufacturers a fee for the right to produce and market devices to operate in that band.[11]

This recommendation—some public or private party should coordinate low-power, unlicensed devices—should be an important consideration in future unlicensed allocations.

Further, while unlicensed spectrum has benefits, allocating spectrum for unlicensed use has featured costly failures as well. For instance, the FCC allocated 30 MHz for unlicensed personal communication services (U-PCS) in the 1990s. The band generated very little economic activity and it took years before the FCC even approved a device for the 10 MHz portion allocated for data transmissions.[12] Meanwhile, the adjacent *licensed* PCS spectrum provides service for millions of cellphone subscribers.[13]

A serious and growing problem is that unlicensed allocations frustrate market transactions since there is typically no band manager in unlicensed bands. The infamous, multibillion dollar failure of LightSquared in 2012 was caused by the allocation of spectrum for unlicensed devices—GPS receivers using spectrum adjacent to LightSquared's spectrum.[14] That episode illustrated how unlicensed users, unlike licensed users like MetroPCS, make repurposing spectrum for other services nearly impossible.

The technical debates about interference between GPS and LightSquared's proposed LTE mobile phone network miss the fundamental problem. The economic waste and bankruptcy resulted because of the nature of the rights the FCC allocated for GPS: LightSquared had no single GPS band manager to bargain with because GPS devices are unlicensed and sold by many companies to millions of consumers and businesses. Much like no one is able to go door-to-door to remove old baby monitors and cordless phones in other unlicensed bands, LightSquared could not reasonably track down and compensate millions of GPS users in order to mitigate interference issues with the proposed LightSquared cellphone network. Nor could millions of GPS users effectively coordinate to pay LightSquared to use a lower-powered phone network that wouldn't interfere with their GPS devices. In sum, "with spectrum use rights defined

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[10] Economists estimated in 2009 that the wireless phone market yields an annual consumer surplus of at least $150 billion. Thomas W. Hazlett and Roberto E. Muñoz, "A Welfare Analysis of Spectrum Allocation Policies," *RAND Journal of Economics* 40 (2009): 424–25. More licensed spectrum and technology upgrades since 2009 presumably increased this figure.

[11] Evan Kwerel and John Williams, "A Proposal for a Rapid Transition to Market Allocation of Spectrum" (OPP Working Paper No. 38, Federal Communications Commission, Washington, DC, 2002), 7–31.

[12] Thomas W. Hazlett, "Optimal Abolition of FCC Spectrum Allocation," *Journal of Economic Perspectives* 22 (2008): 103–14.

[13] Ibid.

[14] See Thomas W. Hazlett and Brent Skorup, "Tragedy of the Regulatory Commons: LightSquared and the Missing Spectrum Rights" *Duke Law & Technology Review* (forthcoming, 2014), http://iep.gmu.edu/wp-content/uploads/2013/04/Tragedy-of-the-Regulatory
-Commons-Hazlett-and-Skorup.pdf.

in small, fragmentary, non-exclusive slices, economic reorganization . . . is impossible due to prohibitive transaction costs."[15]

Licensed spectrum permits secondary markets in spectrum, but the presence of unlicensed devices can prohibit welfare-improving market activity. We needn't merely imagine what might have happened if LightSquared was dealing with a licensee, as opposed to unlicensed users, on the adjacent GPS spectrum. Inmarsat, a satellite licensee, was also using spectrum adjacent to LightSquared's spectrum for satellite phone and data services. LightSquared agreed to pay Inmarsat over $300 million to clear Inmarsat devices from the spectrum, which permitted Inmarsat to upgrade their users' devices to those that used different spectrum bands.[16] Had there been a licensed GPS band manager to bargain with, the United States might have another national wireless carrier today—not a multi-year bankruptcy proceeding and the destruction of billions in capital investment.

When there are no band managers to coordinate and internalize the benefits and costs of replacing or removing devices, technology stagnates, deals fall apart or are never considered, and consumers lose out. Several academics have made this argument and the scholar consensus seems to be that with some tweaks to the unlicensed rules, like the ones Kwerel and Williams, Faulhaber and Farber,[17] or De Vries and Weiser[18] describe, the FCC could permit the consumer benefits that low-power unlicensed technologies like wifi create. Crucially, the FCC should change its rules so that there is one band manager or a consortium of band managers[19] that can replace consumer devices when bands get congested.

3. Spectrum sharing is one proposed technological solution that addresses the issue of spectrum scarcity and encourages efficiency. There are multiple ways to share spectrum, including geographic sharing, temporal sharing, and sharing through dynamic spectrum access. In July 2012, the President's Council of Advisors on Science and Technology (PCAST) issued a report on ways to realize the full potential of government held spectrum. The report concluded that sharing is the most efficient way to utilize spectrum and directed the Secretary of Commerce to immediately identify 1,000 MHz of federal spectrum for shared use.

However, others assert that spectrum sharing is only part of the solution to spectrum scarcity and that clearing unused or underused federal for exclusive commercial use is a vital part of any strategy for maximizing spectrum resources.

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[15] Ibid.

[16] Sarah Young and Paul Sandle, "Inmarsat's LightSquared deal activated," *Reuters*, August 18, 2010, http://uk.reuters.com/article/2010/08/18/uk-inmarsat-idUKTRE67H2W820100818.

[17] Gerald R. Faulhaber and David Farber, "Spectrum Management: Property Rights, Markets, and the Commons" (Telecommunications Policy Research Conference Proceedings, 2002), 17–18, http://assets.wharton.upenn.edu/~faulhabe/SPECTRUM_MANAGEMENTv51.pdf.

[18] J. Pierre de Vries and Philip J. Weiser, "Unlocking Spectrum Value through Improved Allocation, Assignment, and Adjudication of Spectrum Rights" (Discussion Paper 2014-01, The Hamilton Project, Washington, DC, 2014), 18, http://www.brookings.edu/~/media/research/files/papers/2014/03/24%20unlock%20spectrum%20value%20through%20improved%20allocation/thp_devriesweiserdiscpaper.pdf (recommending the use of "band agents" to represent unlicensed users and permit economic bargaining).

[19] See de Vries and Weiser, "Unlocking Spectrum Value," 2014, 18.

In order to enable this sort of reallocation, bipartisan legislation has been introduced in the House that would allow government spectrum users an option to relinquish spectrum and receive a portion of net auction revenues instead of relocation costs, a structure similar to that of the broadcast television spectrum incentive auctions. What should be done to encourage efficient use of spectrum by government users?

PCAST did not conclude simply that spectrum "sharing" is the way forward in spectrum management. As this question states, there are several ways to share federal spectrum, including geographic sharing, temporal sharing, and sharing via dynamic spectrum access. PCAST instead concludes that dynamic spectrum access is the superior method of sharing,[20] a hasty conclusion given the complex problems posed by this young technology.

PCAST and others draw a false distinction between "sharing" and "exclusive licenses."[21] In fact, every wireless user and so-called exclusive use licensee is sharing spectrum with several other licensees and millions of other users.[22] A Washington, DC Verizon customer checking Facebook on her smartphone on her after-work bus commute is sharing the "exclusive," licensed 700 MHz and AWS-1 bands with thousands of other users in DC—namely, other Verizon customers, as well as T-Mobile and AT&T customers. "Licensing does not preclude sharing; it often facilitates it."[23]

The relevant question is not, Should there be more spectrum sharing; it is, Who should coordinate spectrum sharing—regulatory authorities or market participants? As the hundreds of millions of users of cellphones and smartphones reveal, market participants with exclusive, flexible licenses have developed institutions and technologies that promote intensive sharing of the licensed airwaves.

Regarding the PCAST recommendations, Faulhaber states, "In essence, the [PCAST] conclusion is that some form of *government-mandated and controlled sharing* is to be implemented. There is no evidence presented for this conclusion."[24] Unfortunately, regulatory authorities using command-and-control—relying on the advocacy of interested parties, not markets—too often provide frequency sharing that only increases the chances of interference and conflict. PCAST's recommendations would largely exacerbate government interventions.

Having spectrum neighbors or co-tenants via mandate dramatically increases the cost, time, and complexity of interference agreements. Gaining regulatory approval to operate on these slivers of spectrum with other parties is especially difficult. As a prominent legal scholar

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[20] President's Council of Advisors on Science and Technology, "Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth" (2012), 11, http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf.

[21] Ibid., vi–29.

[22] Gerald R. Faulhaber, "The Spectrum Opportunity: Sharing as the Solution to the Wireless Crunch," *International Journal of Communication* 8 (2014): 116–21 ("Sharing is often the commercial norm. Licensing does not preclude sharing; it often facilitates it."); Thomas W. Hazlett, "Spectrum Tragedies," *Yale Journal on Regulation* 22 (2005): 242–49, ("Common access among millions of subscribers is organized by network operators . . . .").

[23] Faulhaber, "Spectrum Opportunity," (2014).

[24] Ibid., 17.

quipped, “negotiating spectrum sharing is like getting past robber barons on the Rhine. Deals are so complicated that they often don’t get done.”[25]

Sharing with federal agencies, particularly the Department of Defense, is especially problematic since agencies’ use of spectrum is often related to the protection of life and property.[26] Faulhaber states the crux of the problem: “Federal agencies gain nothing from sharing; they received the spectrum for free, no one monitors their use of it, and no one apparently has the power to take it away from them. Bottom line: Actual sharing of federal spectrum is highly unlikely.”[27]

The travails of ultrawideband (UWB) are illustrative.[28] UWB is a wireless low-power technology used for ground-penetrating radar and data services. Beginning in 1989, its proponents sought regulatory approval to share federal spectrum for UWB commercial applications. UWB uses huge portions of spectrum but is very low power—transmissions from a cellphone are millions of times more powerful than UWB transmissions. Even then, UWB applicants were subjected to a process that can only be described as Kafkaesque as it went—for 13 years—agency to agency, submitting filings and completing interference tests, attempting to show that the technology would not threaten federal operations.

Indicative of agency foot-dragging, a UWB manufacturer noted,[29]

> It took NTIA nearly a year to obtain internal sign off by government users of spectrum to approve with conditions the requests for waivers submitted by [UWB] companies. This despite the fact that the devices . . . were lifesaving instruments for public safety and law enforcement personnel, and all 2500 devices requested, if operating together in a single room, would emit less than one quarter the power of a cell phone.

Eventually, UWB was permitted to share federal spectrum, but not until after that UWB applicant made over 100 trips to DC in six years and spent millions of dollars to push his technology. Another large UWB company backed by Intel went out of business in the meantime. The ordeal led to a 2002 hearing by the House Energy and Commerce Committee where committee chairman Tauzin stated, “I watched this [UWB] proceeding with more than a small degree of horror. . . . [U]ltrawideband has been met with the fiercest resistance of any technology in recent history.”[30]

Widespread sharing between commercial users and federal agencies with dynamic sharing technologies simply is not ready for prime-time[31] (though research should continue). Technology

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[25] Michael Heller, *The Gridlock Economy: How Too Much Ownership Wrecks Markets, Stops Innovation, and Costs Lives* (New York: Basic Books, 2008), 98.

[26] See Brent Skorup, “Bad News from Obama’s memo on federal spectrum,” *Technology Liberation Front*, June 19, 2013, http://techliberation.com/2013/06/19/bad-news-from-obamas-memo/.

[27] Faulhaber, “Spectrum Opportunity,” 2014.

[28] See “The FCC’s UWB Proceeding: An Examination of the Government’s Spectrum Management Process,” (Serial No. 107-114, Hearing Before the Subcommittee on Telecommunications and the Internet, Committee on Energy and Commerce, House of Representatives, June 5, 2002), http://www.gpo.gov/fdsys/pkg/CHRG-107hhrg80674/pdf/CHRG-107hhrg80674.pdf.

[29] Ibid., 42.

[30] Ibid., 3.

[31] Faulhaber, “Spectrum Opportunity,” 2014 (“While these [dynamic sharing] technologies have been known in the laboratories for decades, very few are actually used commercially. Some are so complex that practitioners don’t expect them to be deployed for

has improved in the interim decade since UWB was approved and someday dynamic and temporal sharing may be relatively cheap and safe. As the Commerce Spectrum Management Advisory Committee (CSMAC) proceedings reveal, however, federal users jealously guard their spectrum from possible interference from commercial users.[32] Michael Marcus, an electrical engineer who worked at the FCC for over two decades has written that the possibility of using dynamic sharing techniques, like PCAST recommends, may someday permit commercial users to share spectrum with federal users. Alas, at present, the very conservative limits that agencies impose on commercial users mean that fluctuations in commercial capacity will be a serious issue and harm commercial interest.[33] The possibility of federal agencies permitting widespread sharing with commercial carriers for wireless broadband via, say, 4G LTE deployment is remote.

As this committee knows, federal users do not use their spectrum efficiently. There are policy alternatives that do not require accepting the undesirable status quo and waiting for dynamic spectrum technologies to develop. A few of those alternatives are described below.

> **4. Given the enormous economic benefits of innovation spurred by commercial spectrum availability, both the government and the private sector are concerned with making more spectrum available to meet commercial demand. When discussing available resources, the FCC considers spectrum to be "currently available" if providers have the legal authority to build out and provide services using that band, or "in the pipeline" if it is not currently available for commercial services but there are government plans to make it available to commercial providers within the next three years. Congress and the FCC have worked to increase the amount of spectrum available to commercial providers, including through the provisions for auctions and relocation in the Middle Class Tax Relief and Job Creation Act. What other steps can be taken to increase the amount of commercially available spectrum?**

The FCC could auction off overlay licenses to spectrum currently utilized by commercial and federal users.[34] Winners of overlay licenses would receive the right to use unoccupied frequencies while avoiding frequencies and geographic areas that are occupied by incumbents.[35] The overlay licensee would also receive the right to bargain with the incumbent users over in-kind or pecuniary compensation. After a deal is reached, the incumbent would relocate or cease operations. The FCC does not need a new statute to accomplish this in most

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many years."); Peter Rysavy, "Spectrum Sharing: The Promise and the Reality," (Rysavy Research, 2012), http://www.rysavy.com/Articles /2012_07_Spectrum_Sharing.pdf.

[32] Brent Skorup, "Reclaiming Federal Spectrum: Proposals and Recommendations," *Columbia Science & Technology Law Review* 15 (2013): 90, 115–16, http://www.stlr.org/html/volume15/Skorup.pdf ("Even in the satellite bands, however, where [temporal sharing] is most likely, the CSMAC working group found temporal sharing to pose substantial challenges, particularly the unproven nature of the technology.") (internal citation omitted).

[33] Michael J. Marcus, "Sharing Government Spectrum with Private Users: Opportunities and Challenges," *IEE Wireless Communications* 16 (2009): 4.

[34] See Brent Skorup, "Getting Away from GOSPLAN," *Regulation* (2014): 18–19, http://object.cato.org/sites/cato.org/files/serials/files /regulation/2014/1/regulation-v36n4-7.pdf.

[35] See Hazlett, "Optimal Abolition," 2008, 103 (discussing overlay licenses as an alternative to the broadcast television incentive auction).

commercial spectrum bands, but congressional approval or encouragement would bring certainty to the process.

For federal incumbents, Congress might also consider proposals similar to "BRAC the spectrum," whereby a panel of spectrum experts would recommend bands of spectrum where federal incumbents would be removed.[36] Giving a panel of experts congressional authority to clear federal users would speed up the process of increasing the amount of commercial spectrum.

In the long-term, agencies need to relinquish their spectrum and pay approximately market rates for the resource. As Thomas Hazlett, a former FCC chief economist, and I recently wrote,

> Spectrum is an input into an output. It is that output, wireless communication, that the government agency needs to consume. It is difficult to know, objectively and from outside an actual situation, how much of each ingredient is the right amount to use. It is impossible to know what will be the right amount (or type of spectrum) in the future. Better to let markets configure the inputs, and governments to buy the outputs. . . .
>
> The present alternative locks in a given amount of spectrum and then directs agencies to construct their own network from there. It makes no more sense than shipping police departments specified quantities of auto parts, mandating that they use this much—no more, no less, no different—for the construction of police cars.[37]

To the extent agencies need their own spectrum, scholars have proposed ideas like an agency that holds spectrum on behalf of federal agencies and leases spectrum at approximately market rates to the agencies that require spectrum.[38]

> **5. In order to issue spectrum licenses, the Communications Act requires the FCC to make an affirmative finding that granting the license serves the public interest, convenience, and necessity. Moreover, the Act prohibits the FCC from basing its finding on the expectation of auction revenues. Should the Act permit the FCC to use expected auction revenue as the basis for a public interest finding? What criteria should the FCC consider as part of its analysis?**

The FCC's public interest standard is infamously vague and causes tremendous amounts of rent-seeking. Federal law states that no spectrum assignment can be transferred "except upon application to the Commission and upon finding by the Commission that the public interest, convenience, and necessity will be served thereby."[39] Legal scholar and former congressional investigator Bernard Schwartz noted decades ago that this public interest standard "gives the Commission well-nigh complete latitude to act in individual cases as it wishes—and it is not even subject to the need for maintaining the corpus of its law consistent."[40]

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[36] Skorup, "Reclaiming Federal Spectrum," 2013, 90.
[37] Hazlett and Skorup, "Tragedy of the Regulatory Commons," 2014, 13–14.
[38] Skorup, "Reclaiming Federal Spectrum," 2013, 90 (describing a proposal to create a GSA-like agency that leases out spectrum to federal users).
[39] 47 USC § 310(d). See 47 CFR § 1.945(c) ("The Commission will grant the [license] application without a hearing if . . . the Commission finds . . . that . . . [a] grant of the application would serve the public interest, convenience, and necessity.").
[40] Bernard Schwartz, "Comparative Television and the Chancellor's Foot," *Georgetown Law Journal* 47 (1959): 655–57.

The FCC "was created by the Communications Act for the purpose of regulating broadcasting in the public interest."[41] As the FCC has said, "the underlying purpose of the Communications Act [is] to effectuate the policy against monopolization of broadcast facilities . . . ."[42] That 80 year-old justification is archaic in a world of hundreds of cable channels and radio programs and countless sources of online content. As long as the public interest standard remains, FCC commissioners will continue to use noneconomic and anticonsumer factors in licensing decisions. The FCC should be required to judge licensing decisions according to a consumer- or social-welfare competition standard, much like the antitrust agencies judge competitive behaviors.

> **6. The FCC's existing process manages spectrum use through allocation and assignment—bands are allocated for specific services or classes of users, and licenses for use of specific portions of spectrum are assigned to entities. Many of the existing allocations were made because certain spectrum bands are better suited for certain uses. However, changes in technology have changed assumptions over the years. While restrictions have eased in recent years, there are still certain limited-use spectrum licenses. Flexible use licenses permit licensees to use their spectrum for any service, including wireless, broadcast, or satellite services. Should all FCC licenses be flexible use? In what instances should the Commission exercise control over the service offered? How can the Act enable better use of spectrum, either flexible or specified?**

The committee understates the problem. Hazlett points out that "the overwhelming proportion of economically important bandwidth is reserved for limited and specific uses, unavailable for market allocation."[43] A 2003 FCC staff report likewise concluded that "the command-and-control model currently dominates today's policy."[44] This Soviet-style industrial planning results in tremendous waste and rent-seeking.[45]

All commercial licenses should be flexible use in order to permit firms to freely upgrade equipment, sell spectrum assets, and deliver new wireless services as consumer demands change. To the extent Congress observes unmet social needs with implications for wireless policy—like local news, phone service for the poor, and public safety communications—those needs should be subsidized directly by state and federal governments. Carving out bands of spectrum to promote social needs distorts the supply and economic value of wireless services and should be discontinued promptly.

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[41] Ibid., 655.

[42] FCC, *In the Matter of 1998 Biennial Regulatory Review – Review of the Commission's Broadcast Ownership Rules and Other Rules Adopted Pursuant to Section 202 of the Telecommunications Act of 1996*, MM Dkt. No. 98-35, 15 FCC Rcd 11058, 11067 (2000) (quoting Amendment of Multiple Ownership Rules, 9 RR 1563 (1953)). See also NBC v. United States, 319 U.S. 190, 219 (1943) (quoting FCC v. Pottsville Broadcasting Co., 309 U.S. 134, 137 (1940)).

[43] Thomas W. Hazlett, "Optimal Abolition of FCC Spectrum Allocation," *Journal of Economic Perspectives* 22 (2008): 103–05.

[44] FCC, "Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues," (OSP Working Paper Series No. 39, May 2003), 11, http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-234741A1.pdf.

[45] Faulhaber and Farber, "Spectrum Management," 2002, 5.

GPS Innovation Alliance

April 25, 2014

VIA ELECTRONIC MAIL

Honorable Fred Upton
Chairman, Energy and Commerce Committee
US House of Representatives
2125 Rayburn House Office Building
Washington, DC 20515

Honorable Greg Walden
Chairman, Communications and Technology Subcommittee
Energy and Commerce Committee
US House of Representatives
2125 Rayburn House Office Building
Washington, DC 20515

Dear Chairman Upton and Chairman Walden:

The GPS Innovation Alliance is pleased to submit the attached comments responding to the Committee's questions on spectrum policy. Thank you for the opportunity to present our views on these important issues. We look forward to working with the Committee and its staff.

Sincerely,

James A. Kirkland
President

6. The FCC's existing process manages spectrum use through allocation and assignment—bands are allocated for specific services or classes of users, and licenses for use of specific portions of spectrum are assigned to entities. Many of the existing allocations were made because certain spectrum bands are better suited for certain uses. However, changes in technology have changed assumptions over the years. While restrictions have eased in recent years, there are still certain limited-use spectrum licenses. Flexible use licenses permit licensees to use their spectrum for any service, including wireless, broadcast, or satellite services. Should all FCC licenses be flexible use? In what instances should the Commission exercise control over the service offered? How can the Act enable better use of spectrum, either flexible or specified?

While not expressly defined, "flexible use" is described anecdotally in an FCC Technical Advisory Committee White Paper as contemplating cellular network architectures with the operational characteristics that accompany cellular networks – very high-power base stations communicating with portable or handheld devices.[1] In other words, the technical rules around flexible use will permit uses up to and including high power mobile network downlinks. Recent FCC discussion of spectrum issues has focused on the goal of maximizing the amount of "flexible use" spectrum, positing that "[t]o meet the rapidly increasing demand for wireless capacity, wireless systems must operate in ever closer proximity in frequency, space and time."[2/] While such a regime provides a great measure of freedom to the licensee who acquires flexible use spectrum, this flexibility comes at a cost to any adjacent spectrum holder, who will be expected to be able to accommodate the full range of permitted operations, up to and including very high powered operations. If the adjacent band use is not immediately compatible with high powered use, the TAC White Paper appears to suggest that adjacent spectrum holders will be forced to accommodate the use over time.[3]

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[1] *See*, *e.g.*, TAC White Paper. at 13 (explaining that licensees should assume "as a starting point that the adjacent band will be re-allocated for use as a cellular downlink"). *See, e.g.*, *id.* at 36 (discussing Kwerel & Williams recommendation that flexible use be defined as "a dense deployment of base, mobile and fixed transmitters operating at fully functional power levels typical of a modern wireless cellular architecture"); *see also* Kwerel, E. and Williams, J., "Solving the Receiver Problem Without Receiver Standards: FCC Workshop on Spectrum Efficiency and Receivers," March 13, 2012, *available at* http://transition.fcc.gov/bureaus/oet/receiver-workshop1/Session6/SESSION-6-1-Kwerel-Williams-FCC.pdf

[2/] *FCC Technological Advisory Council White Paper "Interference Limits Policy: The Use of Harm Claim Thresholds to Improve the Interference Tolerance of Wireless Systems," February 6, 2013, available at* http://transition.fcc.gov/bureaus/oet/tac/tacdocs/WhitePaperTACInterferenceLimitsv1.0.pdf at 5.

[3] This could be accomplished, for example, by permitting the flexible use licensee to increase power of operations over time through an increasing "harm claim threshold." Under a harm claim threshold approach, the adjacent band user would not be able to complain about interference below the progressively increasing harm claim threshold, so that it would effectively bear the burden of modifying its equipment and operations to tolerate the progressively high powered operations next door. *See TAC White Paper, Sec. 3.2(pg. 16) and Sec 5 (pg. 24).*

If this kind of flexible use regime were to become the default framework for licensing spectrum newly freed up for broadband use, there is a tremendous potential for inefficiency in spectrum use, unnecessary costs, and distortion of the development of the full range of technologies that require radio spectrum to operate. In order to see this potential, consider a likely scenario: the FCC is able to "clear" a frequency band for flexible use, but this band is adjacent to a band with existing users. The FCC phases in flexible use over time (say, five years), so that at the end of the phase-in period, the adjacent band licensee will be required to accommodate uses of the flexible use band up to and including high power mobile network downlinks. Even assuming such accommodation is technically possible, this regime, from its inception, imposes engineering and development costs on those who make devices for use in the adjacent band, since those device manufacturers will need to begin investing in changes to their equipment in order to ensure their devices will be in a position to accommodate high powered use in adjacent bands in five years. These investments may or may not prove to be necessary, since a flexible use licensee may, over time, decide not to deploy high powered mobile broadband downlinks in the relevant spectrum. There may also be hidden costs in forcing this change. For example, a spectrum-based technology that worked perfectly well when it did not have to be engineered to withstand high powered operations in the adjacent flexible use spectrum, may simply not work as well, or not work at all, under the new constraints. If flexible use becomes a common framework, the effect may be that spectrum-based technologies that cannot be engineered to accommodate high powered operations will never see the light of day, chilling potential investment and development. The costs of this will be entirely unknowable.[4]

The TAC White Paper simply assumes, without providing technical evidence, that with the right amount of time and some unknown level of investment in new technology or alternative product design, any spectrum use should be able to accommodate high-powered, cellular-like operations in directly adjacent spectrum. This assumption has not been thoroughly tested and validated, and based upon past

[4] It could be argued that licensees will be able to negotiate private transactions to rationalize their respective spectrum uses, so that unnecessary costs can be avoided in this manner. As an initial matter, however, one impetus to having a set of default rules around flexible use and corresponding interference rights or harm claim thresholds is to *avoid* reliance on privately negotiated transactions in order to permit spectrum use, so this would not appear to be an adequate safeguard. Moreover, as the TAC White Paper recognizes, there are common scenarios in which spectrum users may not be represented by a party that is capable of "negotiating" on its behalf, such as unlicensed users and users of "decoupled" receivers. In any case, the party holding flexible use rights will have superior "rights" to impose interference on adjacent band licensees who do not have flexible use rights, and so may extract an effective "tax" from adjacent band licensees in any private negotiation. It is not obvious why such a tax makes sense, and in any case it would similarly distort the development of alternative spectrum uses.

instances involving significant interference between dissimilar uses in close spectral proximity, may be unfounded. If the assumption is incorrect, adoption of a "zoning" and re-farming approach, which groups similar uses together (*e.g.*, low-power and satellite uses) is more appropriate and could actually produce more usable spectrum by, among other things, reducing the need for guard band spectrum and minimizing the number of band "edges" between dissimilar uses. In any case, before enshrining "flexible use" as the default authorization regime for spectrum across the board, the FCC and affected spectrum users must thoroughly analyze whether it will be technically feasible for the full range of spectrum uses to reasonably accommodate high-power cellular use in adjacent bands.

Premature Predictive Judgments Yield Bad Policy

Premature or overbroad application of "flexible use" in spectrum licensing also risks repeating the spectrum management mistakes of the past and wrongly perpetuating current technological and market circumstances well into the future, far beyond the horizons of predictability. Equating flexible use with high-powered cellular-based systems presumes that current technology for delivering mobile broadband will continue to predominate into the indefinite future. This view should be subjected to healthy skepticism. As a general matter, the FCC's ability to make predictive judgments about future technological developments is limited. That is why the FCC is generally reluctant to make technological mandates.[5/] In fact, the limitations of the FCC's ability to make predictive judgments are highlighted by the fact that an earlier set of technological predictions created the current spectrum conundrum. It is clear, but only in hindsight, that when the FCC first allocated spectrum for satellite use, it overestimated the need for satellite-based services. As a result, very successful and efficient satellite based uses (*e.g.*, GPS) sit side-by-side with satellite services that currently meet mainly niche market needs (*e.g.*, MSS).

In fact, there are already good reasons to doubt whether extrapolation of "flexible use," as currently conceived, to serve as the fundamental basis of spectrum policy in the future, is sound. It is already clear that low power Wi-Fi uses are an important part of the broadband wireless service ecosystem. In addition to providing the most common form of distribution of broadband services within

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[5/] *See, e.g.*, *Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz*, Report and Order, GN Docket No. 13-185, FCC 14-31, ¶ 105 (rel. Mar. 31, 2014) ("Mandating a particular industry standard such as LTE would hamstring innovation and development and be contrary to the Commission's policy to preserve technical flexibility and refrain from imposing unnecessary technical standards."); *Expanding Access to Broadband and Encouraging Innovation Through Establishment of an Air-Ground Mobile Broadband Secondary Service for Passengers Aboard Aircraft in the 14.0-14.5 GHz Band*, Notice of Proposed Rulemaking, 28 FCC Rcd. 6765, ¶ 101 (2013) (explaining that the Commission "strive[s] to establish technology neutral rules that allow for competing technologies and changes in technology over time").

the home, Wi-Fi, with its "offload" of traffic from carrier mobile broadband networks onto local area Wi-Fi networks, has become an increasingly important factor in overall carrier capacity planning. Recent forward looking studies also recognize that lower power, less centralized spectrum uses will assume increasing importance in the future.[6]

Flexible Use As Currently Defined May Be Incompatible With Important Spectrum Uses

While these concerns apply to spectrum uses generally, it is easy to see that particular kinds of technologies are more likely to be adversely affected by overly broad application of flexible use rights. The recent experience with LightSquared and GPS highlights the difficulties of coordinating high powered terrestrial operations with satellite uses in nearby spectrum, as discussed in the response to Question 9 on Receiver Standards. The fact remains that it was technically impossible for many GPS receivers to accommodate LightSquared's proposed deployment of high powered terrestrial mobile broadband downlinks and related uplinks in the bands adjacent to GPS.

The difficulties of coordinating flexible use, as currently conceived (high powered terrestrial transmissions), with satellite uses is cause for serious concern. In addition to GPS, two other highly successful spectrum uses are satellite based: direct-to-home satellite video and digital satellite radio. In the future, with the advent of the "internet of things" and the need to access to data literally everywhere (as opposed to the expansive but still limited footprints of high powered cellular based networks), it is not hard to imagine substantially increased demand for mobile services which take advantage of the ubiquitous coverage of satellites.

For example, autonomous vehicles require truly ubiquitous access to both satellite navigation and satellite communication signals (GNSS signals augmented for precision with satellite delivered corrections data). Motorists can currently tolerate lack of cellular coverage on long trips through lightly populated areas, since the worst case is the inability to make a call or access the internet for a limited period of time. The same cannot be said if your vehicle is relying on data signals for navigation, collision avoidance, and route optimization. While the FCC may have over-allocated spectrum for satellite

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[6] *Report to the President Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth*, Executive Office of the President, President's Council of Advisors on Science and Technology, at vi (July 2012) (noting an "important" trend that "instead of just the tall cell towers that provide coverage for very large geographic areas, many wireless services are already moving to 'small cell' operations that provide services for very small geographic areas, reducing the potential for interference so that other services may operate much closer to them. The huge explosion of Wi-Fi services is one example of this evolution.").

applications in the past, we respectfully submit that it is equally dangerous to swing the pendulum to the opposite extreme and assume that new high-value satellite services will not develop in the coming decades. Wholesale reallocation of spectrum near critical satellite uses such as GPS for "flexible use," as currently conceived, rather than preserving appropriately sized "quiet neighborhoods" for satellite, is likely to prove a costly mistake.

9. As discussed above, interference can pose a major problem to efficient and full use of spectrum by providers. The FCC sets limits on transmissions, but doesn't regulate the receivers used by wireless devices to receive wanted signals and eliminate the noise coming from the other surrounding spectrum bands. Underperforming receivers can prevent a device from operating properly. While the FCC has used tools like guard bands to mitigate the potential for interference, recent examples of receiver overload have shown that these efforts may not be enough as demand for spectrum increases but resources become more and more constrained. Some have proposed receiver standards as a solution, but others argue that such a step could result in over-engineering and higher consumer prices. What is the best balance between mitigating interference concerns and avoiding limiting flexibility in the future? Can engineering and forward-looking spectrum strategies account for the possibility of unanticipated technologies and uses in adjacent spectrum bands? How do we promote flexibility without unreasonably increasing the cost of services and devices? Does the Act provide the FCC tools to address this problem?

Policy Pitfalls

Interference is indeed a major impediment to efficient use of spectrum. The potential for interference can both degrade valuable existing uses of spectrum and inhibit new high value uses. While there is certainly a compelling need to make underutilized spectrum available for new uses, or to add capacity for existing uses such as mobile broadband, changes in technical rules or policies affecting existing services to enable these new uses can impose costs and performance penalties to innovative and successful spectrum uses. The public interest requires that the costs and benefits of significant changes be weighed carefully, especially when there are considerable numbers of users who are dependent on an existing spectrum use. This can be extraordinarily difficult to do, and the FCC has struggled with structuring fact based processes with reasonable time frames and regulating with an appropriately long term perspective.

There has also been a natural tendency to view spectrum management issues through the prism of current market and technological circumstances, even though resulting decisions will shape market conditions and the development of technologies for decades. The current FCC priority of maximizing availability of spectrum for mobile broadband services delivered through a network of relatively high powered base stations requires caution: if long term spectrum management decisions are excessively weighted in favor of enabling spectrum uses with this highly centralized, capital intensive model, dissimilar but equally important spectrum uses could easily be penalized and alternative spectrum uses may be significantly hampered.[1]

[1] *See* the discussion in response to Question 6. It is already clear that low power Wi-Fi uses are an important part of the broadband wireless service ecosystem. In addition to Wi-Fi's providing the most common form of distribution of broadband services within the home, "offload" of traffic from carrier mobile broadband networks onto local area Wi-Fi networks is an increasingly important factor in overall carrier capacity planning. Recent forward looking studies already recognize that lower power, less centralized spectrum uses will assume increasing importance in the future. *Report to the President Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth*, Executive Office of the President, President's Council of Advisors on Science and Technology, at vi (July 2012) (noting an "important" trend that "instead of just the tall cell towers that provide

The debate over the need to impose "receiver standards" on GPS devices, for example, well illustrates the difficulties inherent in spectrum management. Reducing the potential for interference between large scale, high power mobile broadband networks and other ubiquitous uses (such as GPS) presents formidable technical challenges, and given the ubiquity and importance of both technologies and their importance to our nation's economy, changes in policy and technical standards present unique risks of imposing unknown and unknowable costs, and distorting technological developments and beneficial innovation. Consideration of receiver standards in isolation from the broader challenges involved in reconciling these important spectrum uses could easily lead to bad spectrum policy decisions.

Technical Considerations

Managing potential interference between divergent spectrum uses is a very complex problem, requiring multiple levels of detailed engineering analysis. A few general parameters, however, tend to dominate the equation; namely, the relative technical characteristics of the uses (e.g. similarity or dissimilarity of transmitter power and receiver sensitivity between the systems), and the proximity of the uses in space (or geography) and frequency. Similar uses are easier to coordinate, while dissimilar uses are more difficult to coordinate to the extent that they are in adjacent or nearby frequency bands, and where transmitters and receivers are operated in close spatial or geographic proximity.

Two common scenarios illustrate the basic relationships. First, mobile carrier base station downlink transmissions can be proximate in frequency and have transmitters located on the same tower (be proximate in space), but can be operated together with relative ease in part because they have very similar technical characteristics (power levels, common timing, signal characteristics) and because there are longstanding engineering techniques for coordinated operation of such fixed facilities. High powered television or radio stations can operate on the same frequencies, if they have sufficient geographic separation. Even radio and television stations operating on different but proximate frequencies must be separated geographically to avoid interference to television or radio receivers.

In contrast, management of potential interference between carrier based mobile broadband operations and the reception of satellite to earth transmissions, such as GPS signals, as considered in the recent LightSquared proceedings, presents an entirely different and worst case scenario. First, the relative technical characteristics of the uses could not be more different. Mobile broadband downlink transmissions are very high powered relative to the satellite signals as received on earth – literally billions of times stronger. Even mobile broadband handset (uplink) transmissions can be billions of times stronger than GPS satellite signals as received on earth when a mobile handset is transmitting in close proximity to a GPS receiver (for example, when the passenger in the front seat of a car with a GPS navigation system is using his or her cell phone).

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coverage for very large geographic areas, many wireless services are already moving to 'small cell' operations that provide services for very small geographic areas, reducing the potential for interference so that other services may operate much closer to them. The huge explosion of Wi-Fi services is one example of this evolution.").

While the "undesired" (potentially interfering) mobile broadband signal is very strong, on the one hand, GPS receivers, on the other hand, must be extraordinarily sensitive to pick up the "desired" GPS signal. These divergent power levels make coordination between these systems exceedingly difficult due to the fact that GPS signals as received on earth are below the thermal noise floor (the level of noise occurring naturally and apart from manmade sources) which prevails in the GPS frequency band, and receivers perform an extraordinary engineering feat to extract the signals from the noise and then process them to provide accurate location information. To do this, GPS receivers must have extremely sensitive receiver front ends, employ extremely sophisticated signal processing functions, and utilize multiple signal processing stages, all of which are adversely affected by interfering "noise."

The proximity variables involved in avoiding interference between terrestrial and satellite services are as challenging as any the FCC has faced in the past. Spatially, mobile broadband networks must be effectively ubiquitous from a user standpoint – users will take mobile handsets everywhere, so uplink transmissions are ubiquitous, and carriers design their networks to have downlink cell coverage where the vast majority of the people are the vast majority of the time. GPS, which is almost exclusively a mobile spectrum use, has an even more ubiquitous footprint. GPS satellite signals are available nearly everywhere, and, with over a half a billion GPS devices in everyday mobile use in the US, including GPS receivers in almost every cell phone, GPS receivers will be in close proximity to fixed or mobile broadband transmitters the vast majority of the time.

Moreover, the effect of interference on a GPS device is also very problematic. Unlike interference between mobile communications networks, where the user can observe the results of interference in dropped calls or poor call quality, the positional accuracy of a GPS device can be degraded by interfering noise in a way that is not detectable, can mislead users about their location, and, in the case of automated guidance applications, may cause poor performance or outright malfunctions. In extreme cases of interference, where a GPS receiver "loses lock" on available GPS satellites altogether, the user is left with no means of determining location until the interference is abated. [2]

Case Study: LightSquared and the MSS Band

All of these factors were evident in LightSquared's attempt to use the Mobile Satellite Service for ubiquitous high powered mobile broadband. The international Radionavigation Satellite Service

[2] GPS is a navigation system and operates in a fundamentally different manner from radio communications systems. The primary measurement in GPS involves determination of the timing of bit transitions in the navigation signal, and precise positioning requires sub-nanosecond measurement of bit edges. This is a very different type of function from that typically performed by terrestrial communications receivers, and traditional means of analyzing and mitigating interference in the communications realm may have little relevance to GPS, or may adversely affect receiver performance. For example, terrestrial mobile networks can use techniques such as dynamic power control and can trade off communications speed and reception quality to maintain viable communications sessions. GPS receivers must work with satellite signals that are fixed in nature and make the most of the data that can be extracted from very low power signals buried in the thermal noise and any interfering signals.

("RNSS") allocation (where GPS operates) runs from 1559 MHz to 1610 MHz. LightSquared's MSS spectrum is directly adjacent to this spectrum, with downlink (satellite to earth or base station transmission in terrestrial operation) spectrum between 1525 and 1559 MHz and uplink (earth to satellite or handset transmission in terrestrial operation) between 1626.5 and 1660.5 MHz. LightSquared initially proposed to operate high powered base stations at 1545-1555 MHz, a mere 4 MHz away from the authorized receive band of GPS receivers. It should have surprised no one that this proposed operation caused massive and widespread interference to virtually every category of GPS receiver. No one has seriously argued that it is possible to engineer a broad range of reasonably priced, fully functional GPS devices that could both receive faint GPS satellite signals and also withstand such high powered broadband signals so close in frequency.[3] Both base station and handset transmissions in other portions of the MSS band have also been shown to cause interference to GPS receivers, and such operations require further technical study.

During the debate over LightSquared's proposals, LightSquared frequently claimed that the proven interference between LightSquared's proposed operations and GPS receivers was entirely the result of design characteristics of GPS receivers, which "listened" to LightSquared's frequencies. These characterizations are entirely inaccurate, and, from an engineering standpoint, effectively meaningless as well as misleading.[4] The FCC has long understood that receivers designed to receive one set of frequencies can be "overloaded" by transmissions in adjacent frequencies.[5] The risk is especially high when the difference between the power levels of the "desired" in-band signals and the "undesired" adjacent band signals is great and is even higher the closer the adjacent band signals are in frequency to the desired signals.

The issue of overload interference is not unique to GPS - in fact, virtually any radio receiver can be overloaded if the adjacent frequency signals are in close enough spatial and spectral proximity and the disparity in power is sufficiently great. GPS receivers are typically designed to withstand adjacent band transmissions hundreds of millions of times stronger than GPS signals, and compare favorably to

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[3] Even LightSquared has conceded that the 1545-1555 band is not usable for base station transmissions.

[4] This claim is literally true for a relatively small number of high precision GPS receivers which were designed to receive separate satellite based "corrections" services which were transmitted using LightSquared's satellite services, for which LightSquared happily collected revenue. However, LightSquared made this claim about all GPS receivers, a claim that is misleading and effectively meaningless for the reasons stated in text.

[5] *See, e.g.*, *Amendment of Part 27 of the Commission's Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band; Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band*, Report and Order and Second Report and Order, 25 FCC Rcd 11710 (2010) (evaluating the potential for overload interference to Satellite Digital Audio Radio Service receivers from Wireless Communications Service ("WCS") mobile devices and adopting conditions on WCS devices to help mitigate the potential for such interference); *Service Rules for Advanced Wireless Services in the 2155-2175 MHz Band*, Notice of Proposed Rulemaking, 22 FCC Rcd 17035, ¶ 16 (2007) (expressing concern with overload interference to adjacent channel mobile receivers from AWS-3 operations and proposing to limit the transmitting power of the AWS-3 mobile transmissions to protect such receivers).

other common types of mass market receivers. Recent carefully controlled tests conducted by Aerospace Corporation demonstrated that three typical GPS receivers were better able to withstand adjacent band transmissions, on a relative basis, than digital television and FM radio receivers from reputable television and radio manufacturers.[6]

The possibility of receiver overload and the need to provide spectral separation to avoid overload and protect receivers is routinely taken into account in spectrum planning in other contexts, including mobile services. One common example is the separation of downlink and uplink frequencies in paired mobile spectrum blocks used for frequency division duplex (FDD) mobile technologies, which are by far the most common form of mobile technology. FDD LTE frequency bands are paired to allow simultaneous transmission on two frequencies. The bands must have sufficient spectral separation in order to prevent the transmitted signals from unduly impairing the receiver performance. If the signals are too close in frequency, the receiver will be "blocked" and its sensitivity impaired. The separation between receive and transmit frequencies must be sufficient to enable the antenna and filters to sufficiently attenuate the transmitted signal within the receive band. As a result, the standard separation (or "band gap") between paired uplink and downlink spectrum is significant, as shown in the attached list of LTE bands. In the case of GPS versus mobile downlink operations, the power differential is much higher than the mobile to mobile case, requiring even greater levels of separation than those required to protect mobile receivers under normal operating conditions.

In other words, there is no expectation in the mobile world generally that receiver filtering must be capable of tolerating high powered transmissions in closely adjacent spectrum in normal operations. This reflects a rational balancing of considerations of cost and sound engineering practice for devices (mobile handsets) that are aimed at the mass consumer market. When viewed in this context, it is clear that the susceptibility of GPS receivers to high powered transmissions in adjacent bands is in no way a "problem" with GPS receivers; rather, such a suggestion reflects either ignorance of basic engineering principles, application of a double standard to GPS receivers, or both. Adoption of receiver standards on this basis would be arbitrary and unfair to GPS, and would effectively hold GPS devices to a higher standard than other consumer electronic devices.

Receiver Regulation Should Not Be Considered in Isolation

Since multiple factors affect the likelihood of interference between highly dissimilar spectrum uses, focusing solely on regulation of receiver characteristics is likely to have limited usefulness and may very well be inefficient and harmful to continued innovation in affected spectrum uses. Forward looking receiver performance standards will not solve interference to existing receivers, and a mandated transition to upgraded receivers has clear costs which need to be weighed carefully. On the other hand, having clearly defined receiver protection criteria, which are soundly formulated on a technology neutral basis and which are forward looking in applicability, could enhance predictability in spectrum use. However, incremental improvements in receiver design are unlikely to substantially change

[6] T.D. Powell, "Adjacent Band Interference to Consumer Radio Receivers," Aerospace Corporation Study No.TOR-2013-00046, May 2013.

receivers' susceptibility to interference in the case of highly dissimilar spectrum uses. More fundamental re-engineering of a successful receiver technology such as GPS to accommodate a highly dissimilar use is very likely to lead to losses in performance and a slower pace of innovation in the underlying technology due to the need to adapt designs to engineering challenges unrelated to the purpose of the devices in question.

Receiver regulation could also impede innovation. Determination of receiver standards by the FCC will be very difficult under any scenario, and administration and enforcement of these standards present formidable challenges, especially in the case of GPS.[7] Devices that use GPS for location based applications come in a great variety of form factors and support an immense variety of hardware devices and software applications that rely on GPS, from baseball sized precision devices to smart phones to tiny receivers embedded in watches or running shoes. As a result, design changes intended to mitigate interference from undesired signals, such as including more elaborate filtering, may be possible for some devices, but may simply be impractical for other applications. Over the long term, we believe that the public will be best served by allowing companies to innovate with a wide variety of form factors, rather than implicitly or explicitly requiring engineering changes which effectively limit when and how GPS receivers can be used.

Spectrum "Zoning" Can Provide a More Efficient Means to Avoid Interference

A more straightforward approach, and one which is more likely to be effective than exclusive reliance on mandated receiver standards, is to minimize the number of dissimilar spectrum applications in close spectral proximity to each other. Put another way, similar spectrum uses should be grouped together to the greatest extent possible to minimize the number of band edges or "border areas" where dissimilar uses in close proximity create serious interference challenges. Such an approach would involve more use of a "zoning" approach to spectrum management, as opposed to a "good fences make good neighbors" approach that requires the FCC to engage in extensive rule making and standards development to balance the interests of dissimilar spectrum uses in every border area.

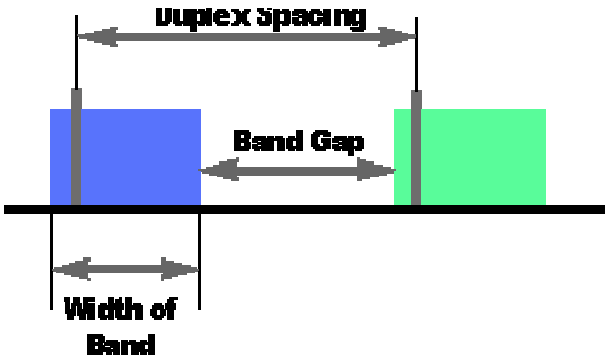
Applying such a "zoning" approach to GPS and adjacent satellite spectrum bands would involve maintaining the historical "quiet neighborhood" and avoiding authorization of high powered uses in this band now or in the future.[8] This spectrum could be the target band for future satellite communications services and expansion of existing satellite services. If there is a long term need to relocate satellite uses from other bands to free up spectrum for terrestrial uses such as mobile broadband, or to address

[7] For example, the "harm claim thresholds" approach recently proposed by the FCC, while it avoids the need for detailed regulation of receiver design, would be very difficult to implement. Comments of the GPS Innovation Alliance, ET Docket No. 13-101, at 16-22 (filed July 22, 2013) (explaining that harm claim thresholds present serious administrative challenges, particularly for "decoupled" devices such as GPS receivers).

[8] Reserving the Mobile Satellite Service band for satellite use would not prejudice existing spectrum rights since MSS license holders never had rights to use MSS spectrum for terrestrial purposes other integrated services to "fill-in" gaps in satellite coverage.

interference issues elsewhere, the FCC could utilize the satellite bands adjacent to GPS to consolidate such satellite uses.

LTE FREQUENCY BAND DEFINITIONS



FDD LTE FREQUENCY BAND ALLOCATIONS

LTE Band Number	Uplink (MHz)	Downlink (MHz)	Width of Band (MHz)	Duplex Spacing (MHz)	Band Gap (MHz)
1	1920 - 1980	2110 - 2170	60	190	130
2	1850 - 1910	1930 - 1990	60	80	20
3	1710 - 1785	1805 -1880	75	95	20
4	1710 - 1755	2110 - 2155	45	400	355
5	824 - 849	869 - 894	25	45	20
6	830 - 840	875 - 885	10	35	25
7	2500 - 2570	2620 - 2690	70	120	50
8	880 - 915	925 - 960	35	45	10
9	1749.9 - 1784.9	1844.9 - 1879.9	35	95	60
10	1710 - 1770	2110 - 2170	60	400	340
11	1427.9 - 1452.9	1475.9 - 1500.9	20	48	28
12	698 - 716	728 - 746	18	30	12
13	777 - 787	746 - 756	10	-31	41
14	788 - 798	758 - 768	10	-30	40
15	1900 - 1920	2600 - 2620	20	700	680
16	2010 - 2025	2585 - 2600	15	575	560
17	704 - 716	734 - 746	12	30	18
18	815 - 830	860 - 875	15	45	30
19	830 - 845	875 - 890	15	45	30
20	832 - 862	791 - 821	30	-41	71
21	1447.9 - 1462.9	1495.5 - 1510.9	15	48	33

LTE Band Number	Uplink (MHz)	Downlink (MHz)	Width of Band (MHz)	Duplex Spacing (MHz)	Band Gap (MHz)
22	3410 - 3500	3510 - 3600	90	100	10
23	2000 - 2020	2180 - 2200	20	180	160
24	1625.5 - 1660.5	1525 - 1559	34	-101.5	135.5
25	1850 - 1915	1930 - 1995	65	80	15

COMMENTS OF THE HIGH TECH SPECTRUM COALITION

The High Tech Spectrum Coalition (HTSC)[1] hereby responds to the Committee on Energy and Commerce's spectrum white paper. Spectrum policy in the coming decades will need to address increasing scarcity combined with rising demands for access to wireless broadband services. The Communications Act must give the Federal Communications Commission (FCC) and the National Telecommunications Information Administration (NTIA) the tools necessary to address how our nation is going to meet rising demand for wireless broadband services. Meeting this challenge will benefit the economy with jobs, innovation and growth, and failure could displace this country's dominance as a wireless leader.

In addition, while federal budget concerns have impacted recent spectrum policy, the members of the HTSC encourage the Committee to recognize positive auction revenues should only be a part of the political equation used regarding spectrum. Various independent economic reports illustrate the vast economic benefit derived from licensed ecosystems that actually dwarf the direct dollars raised in auctions.

There are also areas within the federal government's spectrum holdings where unlicensed use can and should be nurtured. The challenge is to recognize when and where each provides the maximum public benefit; therefore, we urge the Committee to take a long range view and remain committed to a national spectrum policy of clearing 500 MHz of spectrum by the end of the decade.

I. CONSUMER DEMAND WILL DRIVE SPECTRUM POLICY

The Committee understands well the widespread adoption of smartphones, tablets and other devices, capable of running advanced applications, has dramatically increased the need for

[1] The High Tech Spectrum Coalition includes Alcatel Lucent, Blackberry, Cisco, Ericsson, Intel, Nokia Solutions, Qualcomm, and Samsung.

additional spectrum to be allocated to wireless broadband. Passage of the Middle Class Tax Relief Act will transition much needed spectrum for licensed use;[2] however, there will still be a spectrum deficit that must be addressed in the upcoming Communications Act update.

Each subsequent generation of devices, featuring ever more computing power, is putting pressure on 3G wireless networks and hastening the rollout of 4G wireless technologies such as Long Term Evolution (LTE). As 4G networks deploy, the improved network capability will in turn create demand for even more powerful devices and therefore, more spectrum for broadband commercial use. In order to facilitate future evolution in devices, services, applications and content, additional spectrum needs to be allocated. This will help solve problems created by the rapidly growing amount of traffic travelling to and from end-user mobile devices. Currently, there is insufficient spectrum for commercial wireless broadband available for auction in the near future. Without new spectrum resources, available service quality will degrade, prices will likely rise, demand will sag and innovation will suffer. U.S. global leadership in the wireless industry cannot prosper if demand is forced to recede.

The explosive growth in demand for capacity on wireless networks is expected to increase dramatically over the coming years. Cisco's VNI Mobile Forecast predicts wireless data demand will increase at least 8 fold from 2013 to 2018, a compound annual growth rate of 61 percent.[3]

The cause of this skyrocketing consumer demand is linked to advances made in device processing power and access to enriched data. Mobile data traffic by 2018 will be equivalent to

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[2] Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96 §§ 6401-6414, 125 Stat. 156 (2012) ("Spectrum Act"). The NPRM implements the Spectrum Act.

[3] *Cisco Visual Networking Index (VNI): Mobile Forecast Highlights 2013 – 2018,* http://www.cisco.com/assets/sol/sp/vni/forecast_highlights_mobile/index.html#~Country ("Cisco VNI").

383x the volume of U.S. mobile traffic ten years earlier (in 2008).[4] The average smartphone will generate 5,157 megabytes of mobile data traffic per month by 2018, up from 1,214 megabytes per month in 2013, a CAGR of 34%.[5] Today's smartphones consume 42 times more data than a basic handset.[6] In its latest Mobility Report, Ericsson calculated global mobile subscriptions are around 6.7 billion. Of these, 109 million new subscriptions were added during Q4 alone. Global mobile penetration was 92 percent in Q4, 2013.[7] Much of the increase in spectrum use is caused by the video streaming and video communications made possible by these devices. By 2018, it is estimated video streaming and video communication will account for 67 percent of all mobile traffic in North America.[8]

As in the past, some portion of the increased demand will be met by new technologies. For example, deploying LTE technologies will likely double capacity over current 3G technologies.[9] Other capital investments in networks—largely the increasingly expensive approach of dividing cells—will further increase the capacity of existing networks. Some of the increased demand will be met by various demand management techniques such as, Wi-Fi offloading, off-peak transmission and on-device storage, and pricing tiers designed to mitigate peak demand. Improving capacity through network densification, such as applying new network structure/topology, can also relieve data traffic congestion, particularly in urban areas. Small cells are a key enabler of network densification to optimize use of available spectrum resources.

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4 Cisco VNI, select Filter by Country/United States, 2013 Year in Review,

5 Id.

6 *Cisco Global Mobile VNI*, select Filter by Country/United States, Device Growth/Traffic Profiles.

7 *Ericsson Mobility Report* (Interim Update), (February 2014), http://www.ericsson.com/res/docs/2014/ericsson-mobility-report-february-2014-interim.pdf at 2.

8 Bell Labs Mobile Data

9 Peter Rysavy, *Information Week Reports, LTE Huge Technology, Huge Challenges*, March 2012, http://www.rysavy.com/Articles/2012_03_LTE.pdf at 5.

Despite all of these approaches, none will eliminate the need for additional radio spectrum to be allocated to mobile broadband in order to meet rising consumer demand at affordable prices.

By launching the National Wireless Initiative, President Obama also recognizes the opportunity to expand the economy while addressing our nation's mobile broadband deficit.[10] The FCC and the President set a goal of freeing 500 MHz for commercial use.[11] We fully support this goal and believe the Communications Act rewrite should take a long range view on how best to meet that essential target.

II. ECONOMIC BENEFITS OF WIRELESS BROADBAND

The economic benefits of licensed wireless broadband include an increase in U.S. jobs, productivity and innovation. The wireless broadband industry is a critical and rapidly growing sector of the U.S. economy. Its contribution to the overall economy is significant. For each dollar invested in wireless network deployment, U.S. GDP increases by as much as $7-$10.[12] In just one year, the wireless broadband industry generated $28 billion in productivity gains and cost reductions.[13] Deloitte has produced a study that demonstrates a positive, causal relationship between mobile broadband penetration and country GDP growth.[14] Using econometric analysis, Deloitte demonstrates a doubling of mobile data causes GDP per capita to grow by 0.5%.[15] This

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10 White House Wireless Initiative, 2011, http://www.whitehouse.gov/the-press-office/2011/02/10/president-obama-details-plan-win-future-through-expanded-wireless-access.

11 Id.

12 Larry Summers, Speech at New America Foundation, (June 28, 2010) http://www.whitehouse.gov/administration/eop/nec/speeches/technological-opportunities-job-creation-economic-growth.

13 Roger Enter, *The Increasingly Important Impact of Wireless Broadband Technology and Services on the U.S. Economy*, 2008, http://files.ctia.org/pdf/Final_OvumEconomicImpact_Report_5_21_08.pdf. at 2.

14 *What is the Impact of Mobile Telephone on Economic Growth?*, Deloitte, November 2012, http://www.deloitte.com/assets/Dcom-UnitedKingdom/Local%20Assets/Documents/Industries/TMT/uk-tmt-GSMA-report-112012.pdf.

15 Id.

is a significant economic analysis that goes beyond associating mobile broadband penetration with GDP growth and instead, verifies a causal link between increasing mobile data and GDP. Thus, the more licensed spectrum transitioned, the more data will flow on our networks resulting in significant economic growth.

Most importantly, this extraordinary growth in the mobile broadband sector has generated hundreds of thousands of U.S. jobs over the last two decades, and it has the potential to grow hundreds of thousands more jobs if the FCC is able to transition a significant portion of 600 MHz spectrum. Two reports indicate unleashing more spectrum for wireless broadband will have a substantial impact on job creation and the American economy.

The reports concluded that, unleashing 300 MHz of spectrum for mobile broadband by 2016 will spur $75 billion in new capital spending, create between 300,000 to 770,000 new jobs and add $230 billion in GDP.[16] New capital and new jobs are likely to be higher than these conservative figures because economists cannot fully anticipate the effects of future innovation just as a few years ago, they could not predict the explosion of mobile "apps" or the popularity of tablets.

Spectrum is the lifeblood of the wireless broadband industry. Without access to an increasing amount of this finite resource, the U.S. economy will not enjoy the economic and social benefits country needs to stay innovative and competitive in the future. Increases in wireless broadband have measurable impacts and benefits for the entire American economy.

[16] David Sousa, Marc Van Audenrode Analysis Group, *The Impact of 4G Technology on Commercial Interaction, Economic Growth, and U.S. Competitiveness*, Deloitte, August 2011, http://www.mobilefuture.org/page/-/spectrum-impact-study.pdf, at 1-2.

III. SPECTRUM POLICY GOALS

Substantial "market-based" improvements in U.S. spectrum policy have been made on a bipartisan basis over the last three decades. In general, the following policy goals should guide the nation's use of radio spectrum to best facilitate innovative national or regional changes in use and technology.

Clear and assign spectrum for use on an exclusive, flexibly licensed basis

Existing and new spectrum bands should be given flexible use and be exhaustively assigned to exclusive licensees. The FCC should define or clarify interference parameters among licensees where necessary to eliminate uncertainty or ambiguity. The government should use voluntary mechanisms to clear commercial and federal spectrum for high-value uses and technologies (e.g. commercial mobile broadband) on an exclusive licensed basis. Licensees should be free to aggregate or disaggregate frequencies, subject to an antitrust review.

Share spectrum on a Licensed Shared Access (LSA) basis

Where clearing is not feasible, the government should look for sharing opportunities between federal spectrum holders and commercial users on a Licensed Shared Access (LSA) basis permitting operation on a geographic, frequency and, or time basis

Unlicensed Use

Unlicensed allocations may be permitted where they do not or will not foreclose or significantly interfere with licensed use on new or existing allocations. Avoiding foreclosure and interference is important where the spectrum is suitable for high powered, wide area network use. Generally permitting unlicensed use where the opportunity cost of use is low is appropriate, given the existing uses and propagation characteristics in the spectrum band or the interference

mitigating nature of the technology to be used. For example, unlicensed use at 6.78 MHz and 900 MHz, 2.4 GHz, 5 GHz and 60 GHz bands and ultrawideband (UWB) above 6 GHz meet this criterion.

VI. RESPONSES TO WHITE PAPER QUESTION

Question 2:

Unlicensed spectrum plays a vital role in our current wireless ecosystem. Economic and technical factors may make unlicensed use of shared spectrum possible in some cases. In the 5 GHz band, various considerations such as global unlicensed allocation, technological developments and propagation characteristics make additional unlicensed allocation appropriate and beneficial for the wireless ecosystem. We fully support the current efforts to permit shared access for at 5 GHz.

Question 3:

HTSC believes it is essential the federal government adopt spectrum policies that facilitate the most efficient and best use of a critical yet finite resource. To that end, certain limited categories of important federal government uses may continue to require a command and control approach to spectrum management; however, most commercial spectrum allocations should be made available in a forward-thinking, service-flexible and technology-neutral manner.

Wherever possible, the federal government should implement mechanisms to clear underutilized commercial and federal spectrum for high-value advanced services uses and technologies (*e.g.*, commercial mobile broadband) on an exclusive licensed basis. Cleared spectrum should be assigned on a flexible, exclusive licensed basis to enable efficient wide area network (WAN) and associated uses.

In the limited instances in which complete clearing may not be not possible, government should look for band sharing opportunities between federal users and commercial users on a licensed basis. Potential commercial licensees seeking to offer advanced services need a level of certainty regarding spectrum access in order to drive investment decisions. Sharing mechanisms should be cost-efficient and maximize efficient use of the band, and should evolve over time as technology changes.

HTSC strongly supports the approach taken by Reps. Guthrie and Matsui in H.R. 3674, *The Federal Spectrum Incentive Act of 2013*. Creating economic incentives for government users to relinquish spectrum is the proper approach; however we would recommend a more robust incentive for federal users. One percent of the auction proceeds may not be sufficient to convince certain federal users to undertake the process of transitioning out of their bands and into new ones. This is a labor intensive and costly process which may not be worth the potential value of such a low percentage of the proceeds.

Question 4:

Transitioning government spectrum and implementation of the voluntary incentive auction are the most important actions the government can take to increase the amount of commercial spectrum. It is vital the voluntary incentive auction and its subsequent repacking process be as robust and as timely as possible within the authority provided by the Middle Class Tax Relief Act. We also urge timely action regarding the 1755 MHz band in order for it to be commercially available as soon as possible.

Question 5:

The Communications Act should permit the FCC to consider the economic benefits of a particular spectrum allocation. As stated earlier, wireless broadband is an incredible engine for

economic growth, job creation and innovation. The societal benefits associated with transitioning spectrum for commercial broadband use are enormous. The FCC should be able to consider auction revenue and economic impact of its spectrum allocations. As a general policy, the Communications Act should encourage the FCC to allocate spectrum to its highest and best use.

Question 6:

Flexible use licenses have been a very successful spectrum policy. Setting initial flexible rules allows users to realize the opportunity cost of their spectrum usage, leading to investments in technology and much more efficient transitions of use. When users do not realize fully the opportunity cost of their spectrum use, either due to license restrictions or due to being a government entity with limited ability to benefit from more efficient use, spectrum tends to be used inefficiently. It is difficult to determine whether all licenses should be flexible use, but it should be the default position for all allocations.

Question 10:

Currently NTIA is a convener of federal agencies; it has very little authority over its client licensees. Congress should grant NTIA the power to give and take away spectrum rights from federal users. It should be able to mandate government users meet certain efficiency benchmarks and set best practices standards for government users to follow. It should move beyond convener and have the authority to set policy.

House Energy and Commerce Committee
Communications Act Update

Response from the Information Technology Industry Council to white paper number two: Modernizing U.S. Spectrum Policy

April 25, 2014

The Information Technology Industry Council (ITI) appreciates the undertaking of the House Energy and Commerce Committee and the Communications Subcommittee to review, assess, and consider modernization of the Communications Act of 1934. ITI represents 56 of the global leaders in the information and communications technology sector, including manufacturers and providers of hardware, software, network equipment, Internet and e-commerce services, devices, peripherals and social networking.[1] These include companies across the mobile eco-system, including mobile handset and device manufacturers, components suppliers, mobile software and application developers and providers, wireless network equipment manufacturers, and fiber-optic cable companies. We appreciate the opportunity to comment on these issues that are at the core of our companies' ability to innovate, grow, and compete in the domestic and global marketplaces, and meet the demands and expectations of consumers.

Without question, more spectrum must be made available for next generation wireless broadband use in the United States to address the growing consumer demand for data-intensive mobile broadband content and services. Congressional work and activity on spectrum policy in recent years has greatly

[1] Please find a complete list of ITI's member companies at: http://www.itic.org/about/member-companies.dot

increased the amount of spectrum that will be made available for commercial mobile broadband, and given the FCC new tools to ensure spectrum is used more efficiently, but more action is needed to ensure supply keeps up with demand. The Commission should be provided multiple tools enabling them to allocate spectrum in an efficient manner and prevent spectrum from being underutilized due to inflexibility.

Congress, the FCC, and the NTIA must identify opportunities to repurpose commercial and government spectrum with particular attention to spectrum required for commercial mobile technologies. The agencies must also identify opportunities for shared spectrum use along the dimensions of geography, time and frequency for technology platforms that are capable of sharing with incumbent systems, as well as additional opportunities for unlicensed use. There is no silver bullet to address our spectrum needs, but multiple options exist to leverage greater efficiency from this limited resource.

Ericsson's Mobility Report, which was updated last month, notes that global mobile traffic increased 70% between Q4 2012 and Q4 2013.[2] Similarly, Cisco's Virtual Network Index points out that the average amount of traffic per smartphone in 2013 was 529 MB per month, which was 50 percent higher than the average use of 353 MB per month in 2012.[3] Year after year, the trends in these reports are the

[2] Ericsson Mobility Report, Interim Update, February 2014, http://www.ericsson.com/res/docs/2014/ericsson-mobility-report-february-2014-interim.pdf

[3] Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2013–2018, February 5, 2014, http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html

same: skyrocketing mobile data traffic. These are trends that are not going away, and we appreciate the Committee's continued focus on these issues in its second white paper.

While each of the questions posed in the white paper are important as you consider holistic spectrum policy reforms, many are more relevant to licensees and service providers, which are not represented in ITI's membership. Therefore, ITI submits the following responses to questions relevant to our membership:

Discussion and Question 2:

What role should unlicensed spectrum play in the wireless ecosystem? How should unlicensed spectrum be allocated and managed for long-term sustainability and flexibility?

ITI strongly believes both licensed and unlicensed spectrum play an important and symbiotic role in today's mobile ecosystem, and making more licensed and unlicensed spectrum available in the future will be critical to meeting our nation's spectrum needs. In general, ITI supports clearing and auctioning spectrum below 3 GHz whenever possible. ITI also actively supports expanded unlicensed use, most recently in the 5 GHz band specifically, but believes possibilities exist elsewhere.

Discussion and Question 3:

What should be done to encourage efficient use of spectrum by government users?

ITI strongly supports the approach taken in the Federal Spectrum Incentive Auction Act, H.R. 3674, introduced by Representatives Guthrie and Matsui. We believe this approach provides a real incentive for federal users to find

ways to use spectrum more efficiently, and clear spectrum that is not essential for commercial use.

In bands used by federal incumbents, ITI supports relocation, however if that is infeasible, ITI supports innovative approaches such as the spectrum sharing approach in the 3.5 GHz band. If spectrum is essential for use by a government entity, but is not used continually, or in a specific geographic area, a shared access approach is a viable mechanism for increasing commercial use of federal spectrum. As previously mentioned, ITI supports that approach in the Commission's 3.5 GHz rulemaking.

Discussion and Question 6:

Should all FCC licenses be flexible use? In what instances should the Commission exercise control over the service offered? How can the Act enable better use of spectrum, either flexible or specified?

Flexible use licenses have unquestionably resulted in better spectrum management and allowed licensees to more efficiently use spectrum by not preventing adoption of new technologies due to license restrictions. Both existing, and new spectrum bands should be given flexible use and be exhaustively assigned to exclusive licensees.

Discussion and Question 9:

What is the best balance between mitigating interference concerns and avoiding limiting flexibility in the future? Can engineering and forward-looking spectrum strategies account for the possibility of unanticipated technologies and uses in adjacent spectrum bands? How do we promote flexibility without unreasonably increasing the cost of services and devices? Does the Act provide the FCC tools to address this problem?

ITI's member companies make significant investments to develop and bring new devices, with new features and functionality for consumers to the marketplace. The wide array of mobile handsets, with the multitude of options and features have been born through marketplace forces and industry regulation. Technology mandates, particularly around the inclusion of chip sets, would set a terrible precedent and could significantly disrupt the innovation in this space, leading to higher costs for consumers, diminished performance, and an overall reduction in functionality.

Discussion and Question 10:

What role should NTIA play in the licensing and management of spectrum? Is their current role appropriate and necessary, given the potentially duplicative functions of the FCC and NTIA in spectrum allocation and assignment?

Congress should strengthen NTIA's ability to manage the spectrum rights of federal users, or grant that authority to the Commission. Either of these actions would also benefit the question posed in item 3, above.

Again, ITI appreciates the Committee's work to update the Communications Act, and in particular our nation's spectrum policy, which has not been looked at holistically since the mobile revolution that has taken place in the U.S. over the past two decades. We look forward to continuing to work with you and stand by to answer any questions or provide additional information on any topic in this submission.

Respectfully submitted,
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